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LOCKS (WATERWAYS)
INLAND WATERWAYS
MISSISSIPPI RIVER
STRUCTURAL ENGINEERING

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

It is recommended that both the landward lock, the riverward lock and the dam at Lock & Dam no. 1, Minneapolis, Minnesota be completely rehabilitated. Based on studies completed to the date of this report, more detailed studies are required to firmly establish cost estimates, environmental effects, and the construction scheduling necessary to insure the work can be completed in the proposed two year construction period without delaying navigation.

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DEPARTMENT OF THE ARMY
ST. PAUL DISTRICT, CORPS OF ENGINEERS
1210 U.S. Post Office & Custom House
St. Paul, Minnesota 55101

MISSISSIPPI RIVER
STUDY OF ALTERNATIVES FOR REHABILITATION OF LOCK AND DAM NO. 1
MINNEAPOLIS, MINNESOTA

SUPPORTING DATA
FOR
APPENDIX C
STRUCTURAL INVESTIGATIONS

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STRUCTURAL INVESTIGATIONS COMPUTATIONS COMPUTED R.N.M. CHECKED	PROJECT LOCK & DAM No 1 FILE No. 800A DATE 4/21/75 PAGE i OF PAGES

COMPUTATIONS

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STRUCTURAL INVESTIGATION COMPUTATIONS COMPUTED R.N.M. CHECKED	PROJECT LOCK & DAM NO 1 FILE NO. 800A DATE 4/21/75 PAGE iii OF PAGES

MONO-LITH NºS	LOADING CONDITION	ELEV. OF BACKFILL, FT	W.S. ELEV. AT LANDSIDE, FT	W.S. ELEV. AT RIVER-SIDE, FT	LOCATION OF RES ECCENTRICITY FROM e, FT	±(L/6
				UPPER GUIDE WA		
1-7 (L=14.0)	NORMAL OPERATING	732.7	725.2	725.2	3.72	-1
1-6	CONSTRUCTION	732.7	719.7	(EMPTY)	4.22	-1
8-13 (L=18.0)	NORMAL OPERATING	732.7	725.2	725.2	3.40	-0

NOTES:

1. SUMMATION OF HORIZONTAL FORCES
ONE FOOT STRIP ACROSS EACH

2. FACTOR OF SAFETY AGAINST SLIDING
TO COEFFICIENT OF FRICTION $f = 0.$

3. NEGATIVE SIGN INDICATES LOCATIO

4. ALL WATER SURFACE (W.S.) ELEVATION
CONSTRUCTION CONDITION FOR MON

5. FOR 3-DIMENSIONAL ANALYSES e

...V.	LOCATION OF RESULTANT ECCENTRICITY e, FT	FROM MIDDLE 1/3 $\pm(\frac{L}{6}-e)$ FT ③	FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	F.S.O.	ΣH KIPS	ΣV KIPS	SLIDING FACTOR, ΣH/ΣV	F.S.S. ②
...PER GUIDE WALL									
	3.72	-1.39	7.46	0.00	1.43	13	37	.35	1.80
	4.22	-1.89	11.34	0.00	1.57	21	47	.44	1.42
	3.40	-0.40	4.13	0.00	2.06	11	35	.33	1.90

...ONTAL FORCES (ΣH) AND VERTICAL FORCES (ΣV) ARE FOR AN AVERAGE ... ACROSS EACH MONOLITH.

...AINST SLIDING (F.S.S.) IS BASED ON $\phi = 32^\circ$ CORRESPONDING ...RICTION $f = 0.625$ (FOR DAM; $\phi = 33^\circ$, $f = 0.649$)

...CATES LOCATION OF RESULTANT OUTSIDE OF MIDDLE THIRD

...(W.S.) ELEVATIONS FOR INTERMEDIATE WALL ARE INTERCHANGABLE EXCEPT ...TION FOR MONOLITHS 4 & 5

... ANALYSES e_x IS ACROSS THE WALL AND e_y ALONG THE WALL

1

MONO-LITH NOS	LOADING CONDITION	ELEV. OF BACKFILL, FT	W.S. ELEV. AT LAND-SIDE, FT	W.S. ELEV. AT RIVER-SIDE, FT	LOCATION OF ECCENTRICITY e, FT	FROM ±(
					LAND W	
3 (L=32.0')	NORMAL OPERATING (PRESENT)	732.7	704.0	687.2	9.06	
3	CONSTRUCTION — ALL REHABILITATION PLANS. CONDUIT LOWERED, NO CONC. FILL	724.7	704.0	(EMPTY)	7.47	
3	NORMAL OPERATING — AFTER HYDRAULIC IMPROVEMENTS COMPLETED	732.7	704.0	687.2	7.70	
3	IMPROVED NORMAL OPERATING — BACKFILL LOWERED BY 8'	724.7	704.0	687.2	5.61	
4 (L=32.0')	CONSTRUCTION — ALL REHABILITATION PLANS, CONDUIT LOWERED, NO CONC. FILL	722.7	704.0	(EMPTY)	7.44	
4	NORMAL OPERATING — AFTER HYDRAULIC IMPROVEMENTS COMPLETED	732.7	704.0	687.2	8.04	
4	IMPROVED NORMAL OPERATING — BACKFILL LOWERED BY 10'	722.7	704.0	687.2	5.38	

L & D DAM Nº 1

SUMMARY OF STRUCTURAL INVESTIGATIONS

V. R- T	LOCATION OF RESULTANT ECCENTRICITY e, FT	FROM MIDDLE 1/3 $\pm(\frac{b}{6}-e)$ FT	FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	F.S.O.T.	ΣH KIPS	ΣV KIPS	SLIDING FACTOR, ΣH/ΣV	F.S.S.
LAND WALL									
	9.06	+3.73	13.41	0.00	1.54	85	184	.46	1.36
Y)	7.47	-2.14	13.39	0.00	1.57	75	171	.44	1.49
2	7.70	-2.40	16.10	0.00	1.67	85	201	.42	1.48
	5.61	-0.28	12.60	0.00	2.05	66	196	.34	1.85
Y)	7.44	-2.11	13.40	0.0	1.79	71	172	.41	1.52
2	8.04	-2.63	16.00	0.0	1.62	85	191	.45	1.40
2	5.38	-0.05	11.58	0.00	2.06	62	184	.34	1.86

MONOLITH NOS	LOADING CONDITION	ELEV. OF BACKFILL, FT	W.S. ELEV. AT LANDSIDE, FT	W.S. ELEV. AT RIVERSIDE, FT	LOCATION OF RESU[LTANT] ECCENTRICITY e, FT	FROM ... $\pm(\frac{L}{6}$-...
					LAND WA[LL]	
5-15 (L=32.0')	NORMAL OPERATING	732.7	700.0	687.2	7.85	
5-15	NORMAL OPERATING	732.7	704.0	687.2	8.56	
5-15	CONSTRUCTION AND MAINTENANCE	732.7	704.0	(EMPTY)	8.50	
5-15	IMPROVED NORMAL OPERATING 1-1 3/8" Ø BAR TENDON PER ANCHOR SPACED 10 FT	732.7	704.0	687.2	4.86	
5-15	IMPROVED NORMAL OPERATING 2-1 1/4" Ø BAR TENDONS PER ANCHOR SPACED 15 FT	732.7	704.0	687.2	4.30	
5-15	IMPROVED NORMAL OPERATING 3-1 1/4" Ø BAR TENDONS PER ANCHOR SPACED 15 FT	732.7	704.0	687.2	2.50	
5-15	IMPROVED NORMAL OPERATING BACKFILL LOWERED BY 10'	722.7	704.0	687.2	6.59	

LOCK AND DAM NO. 1
SUMMARY OF STRUCTURAL INVESTIGATIONS

EV. RE- T	LOCATION OF RESULTANT ECCENTRICITY e, FT	FROM MIDDLE $\frac{1}{3}$ $\pm(\frac{b}{6}-e)$ FT (3)	FOUNDATION PRESSURE, KSF f MAX	f MIN	F.S.O.T	ΣH KIPS	ΣV KIPS	SLIDING FACTOR ΣH/ΣV	F.S.S. (2)
LAND WALL (CONT'D)									
2	7.85	-2.52	16.50	0.00	1.68	85	202	.42	1.49
2	8.56	-3.23	17.74	0.00	1.57	86	198	.43	1.44
r)	8.50	-3.20	18.84	0.00	1.50	98	212	.46	1.35
2	4.86	0.47	12.10	0.60	2.37	72	203	.36	1.76
2	4.30	1.00	12.00	1.30	2.45	70	212	.33	1.89
.2	2.50	2.83	9.80	3.60	3.27	63	215	.29	2.16
.2	6.59	-1.26	12.33	0.00	1.87	63	174	.36	1.74

2

MONO-LITH NOS	LOADING CONDITION	ELEV. OF BACKFILL, FT	W.S. ELEV. AT LAND-SIDE, FT	W.S. ELEV. AT RIVER-SIDE, FT	LOCATION OF ECCENTRICITY e, FT
				LAND WALL (CONT'	
17 (GATE) (L=20.0')	NORMAL OPERATING	732.7	700.0	687.2	9.70
17	IMPROVED NORMAL OPERATING BACKFILL LOWERED BY 10 FT	722.7	700.0	687.2	6.90
17	IMPROVED NORMAL OPERATING STABILIZED BY 1 3/8 Ø ANCHORS SPACED 10 FT.	732.7	700.0	687.2	6.00
17	IMPROVED NORMAL OPERATING STABILIZED BY 1 3/8 Ø ANCHORS SPACED 10 FT, BACKFILL LOWERED BY 10 FT.	722.7	700.0	687.2	3.20
					LOWER G
1 (L=18.0')	NORMAL OPERATING	VARIES FROM 709.7 TO 732.7	687.2	687.2	7.00
3-13 (L=20.0')	NORMAL OPERATING	697.6	687.2	687.2	2.70
6-12	CONSTRUCTION ([illegible] EMPTY)	699.6 (PLUS 3' of [illegible])	681.0	(EMPTY)	3.22

LOCK AND DAM NO 1
SUMMARY OF STRUCTURAL INVESTIGATIONS

EL. VER. FT	LOCATION OF RESULTANT ECCENTRICITY e, FT	FROM MIDDLE 1/3 $\pm(\frac{L}{6}-e)$ FT	FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	F.S.O.T.	ΣH KIPS	ΣV KIPS	SLIDING FACTOR ΣH/ΣV	F.S.S.
WALL (CONT'D)									
2	9.70	-4.70	26.00	0.0	1.41	94	207	.46	1.38
2	6.90	-1.90	16.44	0.00	1.81	70	200	.35	1.79
2	6.00	-1.0	18.70	0.00	1.71	79	212	.37	1.67
2	3.20	+1.8	11.10	2.50	2.23	55	205	.27	2.34
LOWER GUIDE WALL									
	7.00	-4.00	33.60	0.00	1.26	45	98	.46	1.35
2	2.70	+.63	5.39	0.55	5.75	9	59	.15	4.07
Y)	3.22	+0.11	6.95	0.12	3.78	16	71	.22	2.84

2

MONO-LITH NOS	LOADING CONDITION	W. S. ELEVATIONS (4), FT LANDWARD LOCK	RIVERWARD LOCK	LOCATION OF RES ECCENTRICITY (5), FT e OR e_x	e_y
4-16 (L=40.0')	NORMAL OPERATING	687.2	725.2	7.26	—
4	CONSTRUCTION — REHABILITATION PLAN 2, LANDWARD LOCK REBUILT	(EMPTY)	725.2	6.10	0.20
5	CONSTRUCTION — REHABILITATION PLAN 2 RIVERWARD LOCK REBUILT	(EMPTY)	725.2	7.60	0.51
6-16	CONSTRUCTION AND MAINTENANCE	(EMPTY)	725.2	7.23	—
18 (GATE) (L=35.0')	NORMAL OPERATING	725.2	687.2	12.40	7.90
18	IMPROVED NORMAL OPERATING STABILIZED BY 12 ROCK ANCHORS OF 3-1¼"φ BAR TENDONS PER ANCHOR	725.2	687.2	7.30	5.80
18	IMPROVED NORMAL OPERATING INTERCONNECTION OF MONOLITHS 18 & 19 BY SHEAR KEYS	725.2	687.2	8.75	3.25
18	IMPROVED NORMAL OPERATING INTERCONNECTION OF MONOLITHS 17,18,&19 BY SHEAR KEYS	725.2	687.2	8.30	—

LOCK AND DAM Nº 1
SUMMARY OF STRUCTURAL INVESTIGATIONS

LOCATION OF RESULTANT ECCENTRICITY ⑤, FT e_x	e'_y	FROM MIDDLE ⅓ $\pm(\frac{L}{6}-e)$ FT ⑤	FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	F.S.O.	ΣH KIPS	ΣV KIPS	SLIDING FACTOR ΣH/ΣV	F.S.S. ②
		INTERMEDIATE WALL							
[illegible]	—	−0.59	10.90	0.00	1.94	73	209	.35	1.80
[illegible]	0.20	0.57	5.66	0.00	1.89	76	197	.39	1.81
[illegible]	0.51	−0.9	11.30	0.00	1.90	76	188	.41	1.57
[illegible]	—	0.56	11.32	0.00	2.02	77	217	.35	1.77
[illegible]	7.90	—	74.50	0.00	1.03	130	217	.60	1.04
[illegible]	5.80	—	47.54	0.00	—	130	370	.35	1.77
[illegible]	3.25	—	20.10	0.00	1.75	84	189	.45	1.41
[illegible]	—	−2.46	13.80	0.00	1.74	72	193	.37	1.68

MONO-LITH NOS	LOADING CONDITION	ELEV. OF BACKFILL FT	W.S. ELEV AT LANDSIDE, FT	W.S. ELEV. AT RIVERSIDE, FT	LOCATION OF RESULTA[NT] ECCENTRICITY, FT e OR e_x	e_y	FR[OM] ±(
					RIVER WAL[L]		
1 (OLD RIVER WALL) (L=25.0')	CONSTRUCTION (INVESTIGATION OF OLD RIVER WALL MONOLITH)	709.0	705.0	731.7	6.42	—	
6-16 (L=26.0')	NORMAL OPERATING (I) NEW MONOLITH	690.0	725.2	707.7	9.70	—	
6-16 (L=28.0')	NORMAL OPERATING (II) OLD MONOLITH	690.0	707.7	687.2	3.80	—	
6-16	NORMAL OPERATING COMBINED NEW (I) AND OLD (II) MONOLITHS	690.0	725.2	687.2	2.58	—	
6-16	CONSTRUCTION & MAINTENANCE COMBINED NEW (I) & OLD (II) MONOLITHS	690.0	(EMPTY)	690.0	—	—	
19 (L=32.0')	NORMAL OPERATING "LOCK SIDE AVERAGE" UPLIFT PRESSURE	698.0	725.2	687.2	5.84	—	

LOCK AND DAM NO. 1
SUMMARY OF STRUCTURAL INVESTIGATIONS

...ATION OF RESULTANT ...ENTRICITY, FT e_x	e_y	FROM MIDDLE $\frac{1}{3}$ $\pm(\frac{L}{6}-e)$ FT ③	FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	PILE LOAD KIPS/PILE	F.S.O.T.	ΣH / ΣV KIPS	SLIDING FACTOR, $\Sigma H/\Sigma V$	② F.S.S.
RIVER WALL									
...2	—	-2.26	9.50	0.00	—	1.40	38 / 86	.44	1.25
...70	—	-5.70	35.60	0.00	—	—	64 / 123	.52	1.05
...30	—	+0.86	7.12	0.72	—	—	1 / 109	—	—
...58	—	+6.42	5.54	3.07	P_{MAX} = 50 P_{MIN} = 42 P_H = 13	—	64 / 232	.273	2.01
—	—	—	—	—	P_{MAX} = 98 P_{MIN} = 21 P_H = 2	—	— / —	—	—
...84	—	-0.51	11.86	0.00	P_{MAX} = 130 P_{MIN} = -10 P_H = 21	1.84	63 / 181	.35	1.57

MONOLITH NOS	LOADING CONDITION	ELEV. OF BACKFILL, FT	W.S. ELEV. AT LANDSIDE, FT	W.S. ELEV. AT RIVERSIDE, FT	LOCATION OF R ECCENTRICITY, FT e OR e_x	e_y
19	NORMAL OPERATING "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	698.0	725.2	687.2	7.14	—
19	IMPROVED NORMAL OPERATING-BACKFILL BEHIND MONOLITH "LOCKSIDE AVERAGE" UPLIFT PRESSURE	710.0	725.2	687.2	4.70	—
19	IMPROVED NORMAL OPERATING - BACKFILL BEHIND MONOLITH "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	710.0	725.2	687.2	5.87	—
20 (L=20.0')	NORMAL OPERATING "LOCKSIDE AVERAGE" UPLIFT PRESSURE	690.0	725.2	687.2	8.62	7.25
20	NORMAL OPERATING "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	690.0	725.2	687.2	9.29	7.95
20	IMPROVED NORMAL OPERATING BACKFILL "LOCKSIDE AVERAGE" UPLIFT PRESSURE	710.0	725.2	687.2	7.55	6.95

LOCK AND DAM NO 1
SUMMARY OF STRUCTURAL INVESTIGATIONS

RIVER WALL (CONT'D)

LOCATION OF RESULTANT: ECCENTRICITY, FT e_x	e_y	FROM MIDDLE $\frac{1}{3}$ $\pm(\frac{L}{6}-e)$, FT ③	FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	PILE LOAD KIPS/PILE	F.S.O.T.	ΣH KIPS / ΣV	SLIDING FACTOR $\Sigma H/\Sigma V$	② F.S.S.
	—	−1.80	12.17	0.00	P_{MAX} = 131 P_{MIN} = −23 P_H = 21	1.55	63 / 162	.39	1.41
	—	+0.63	10.61	0.68	P_{MAX} = 117 P_{MIN} = 3 P_H = 16	1.93	49 / 181	.27	2.04
	—	−0.53	10.70	0.06	P_{MAX} = 117 P_{MIN} = −9 P_H = 16	1.63	49 / 162	.30	1.83
2	7.25	—	53.50	0.00	P_{MAX} = 290 P_{MIN} = −151 P_H = 40	—	116 / 202	.59	0.95
	1.95	—	64.20	0.00	P_{MAX} = 234 P_{MIN} = −162 P_H = 48	—	116 / 192	.61	0.90
	6.95	—	45.50	0.00	P_{MAX} = 283 P_{MIN} = −139 P_H = 33	—	96 / 210	.44	1.20

MONO-LITH NO S	LOADING CONDITION	ELEV. OF BACK FILL, FT	W.S. ELEV. AT LAND-SIDE, FT	W.S. ELEV AT RIVER-SIDE, FT	LOCATION OF RESU... ECCENTRICITY (5) FT e OR e_x	e_y	FR... ±
					RIVER WALL		
	IMPROVED NORMAL OPERATING						
20	BACKFILL "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	710.0	725.2	687.2	8.18	7.60	
20	SHEAR KEYS (6) "LOCKSIDE AVERAGE" UPLIFT PRESSURE	690.0	725.2	687.2	5.04	3.89	
20	SHEAR KEYS (6) "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	690.0	725.2	687.2	5.60	5.10	
20	BACKFILL & SHEAR KEYS (6) "LOCKSIDE AVERAGE" UPLIFT PRESSURE	710.0	725.2	687.2	3.90	5.21	
20	BACKFILL & SHEAR KEYS (6) "LOCKSIDE MAXIMUM" UPLIFT PRESSURE	710.0	725.2	687.2	4.49	6.40	

(6) MONOLITHS 19, 20 & 21 INTERCONNECT...

LOCATION OF RESULTANT ECCENTRICITY ⑤ FT e_x	e_y	FROM MIDDLE $\frac{1}{3}$ $\pm(\frac{L}{6}-e)$ FT	③ FOUNDATION PRESSURE, KSF f_{MAX}	f_{MIN}	PILE LOAD KIPS/PILE	F.S.O.T.	ΣH KIPS	ΣV	SLIDING FACTOR $\Sigma H/\Sigma V$	F.S.S. ②
RIVER WALL (CONT'D)										
	7.60	—	52.40	0.00	P_{MAX} = 287 P_{MIN} = -149 P_H = 33	—	96	200	.48	1.15
	3.89	—	14.15	0.00	P_{MAX} = 172 P_{MIN} = -34 P_H = 30	—	79	205	.39	1.42
	5.10	—	14.88	0.00	P_{MAX} = 179 P_{MIN} = -47 P_H = 30	—	79	200	.40	1.39
	5.21	—	13.70	0.00	P_{MAX} = 164 P_{MIN} = -22 P_H = 23	—	66	209	.32	1.74
	6.40	—	13.80	0.00	P_{MAX} = 173 P_{MIN} = -37 P_H = 23	—	66	204	.32	1.70

INTERCONNECTED WITH SHEAR KEYS

LOADING CONDITIONS	WATER SURFACE ELEV., FT			LOCATION OF RESULTANT	
	UPPER POOL	TAIL - WATER	LOWER POOL	ECCENTRICITY e, FT	FROM MIDDLE $\frac{1}{3}$ $\pm(\frac{L}{6}-e)$ (3)

BUTTRESS

LOADING CONDITIONS	UPPER POOL	TAILWATER	LOWER POOL	ECCENTRICITY e, FT	FROM MIDDLE 1/3
NORMAL OPERATING 10K/FT OF CREST ICE PRESSURE	723.2	(EMPTY)	(EMPTY)	4.32	+ 5.81
FLOOD DISCHARGE 1965 FLOOD DAM CAVITY FULL OF WATER	734.7	719.0	719.0	0.96	+ 9.19
FLOOD DISCHARGE 1951 FLOOD WATER IN CAVITY @ RELIEF HOLES LEVEL	731.0	695.5	709.0	0.72	+ 9.41
EARTHQUAKE NORMAL OPERATING WITH EARTHQUAKE BUT WITHOUT ICE PRESSURE	723.2	(EMPTY)	(EMPTY)	2.81	+ 7.32
IMPROVED NORMAL OPERATING 1951 FLOOD ADDITIONAL SAND FILL UP TO EL. 701.25±	731.0	695.5	709.0	0.69	9.44

(6) INTERNAL HYDROSTATIC PRESSURE
EXCEPT NORMAL OPERATING

OF RESULTANT FROM MIDDLE $\frac{1}{3}$ $\pm(\frac{L}{6}-c)$ (3)	BEARING ΣH KIPS	ΣV KIPS	FOUNDATION PRESSURES $f_{MAX.}$ KSF	$f_{MIN.}$ KSF	SLIDING R_T KIPS	R_T KIPS	FACTOR R_T/R_N	F.S.S.
BUTTRESS DAM								
+ 5.81	725	1726	2.53	1.02	530	1903	0.279	2.39
+ 9.19	536	1215	1.36	1.13	297	1366	0.217	2.98
+ 9.41	807	1335	1.47	1.27	669	1525	0.439	1.48
+ 7.32	804	1726	2.27	1.28	609	1911	0.319	2.03
9.44	807	1557	1.48	1.30	667	1542	0.433	1.50

ATIC PRESSURE (UPLIFT) DETERMINED BY FLOW NET METHOD
OPERATING CONDITIONS.

2

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INVESTIGATION OF STABILITY FOR LOCK WALLS COMPUTED M. J. CHECKED R. N. M.	PROJECT L. & D. #1 FILE NO 800A DATE 8.74 PAGE 1 OF ___ PAGES

BACKFILL BEHIND WALLS

NUMBER OF BLOWS FOR 12" PENETRATION

HOLE NO / DEPTH IN FT.	74-22		74-14		74-8	
1	6		20			
2	16		14	SAND	100	
3	28	SAND ROUNDED	12	BACKFILL	40	
4		FINE TO COARSE	20	FINE TO MEDIUM	46	SANDY GRAVEL
5	50		20		36	
6			90	SANDSTONE	42	
7			140		46	GRAVELLY SAND
8						
9	4				80	
10	28				90	SAND
11	88				100	
12						
13						
14					16	
15	12				16	
16	16				14	
17	26					
18						
19					10	
20					20	
					26	
					10	
25					16	
					16	
					16	
30					20	
					30	
					110	
35					82	
					32	

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LATERAL EARTH PRESSURES COMPUTED R.H.M. CHECKED VT	PROJECT LOCK AND DAM No. 1 FILE No. 800 A DATE OCT.1,75 PAGE 2 OF ___ PAGES

The land and guide wall monoliths have been considered to behave essentially as rigid structures. Therefore at-rest earth pressure coefficients have been utilized for calculating lateral forces, modified by reduction factors considering the deformation history of the monoliths and the nature of the granular backfill materials. For monoliths founded directly upon the sandstone (sand) a reduction factor of 0.95 was used. For monoliths bearing upon timber cribs a reduction factor of 0.85 was applied.

LAND WALL, MONOLITHS 1-7 UPPER GUIDE WALL AND MONOLITHS 1-2 LOWER GUIDE WALL

These monoliths are founded directly on sandstone

$\gamma_{moist} = 115$ pcf
$\gamma_{saturated} = 130$ pcf
$\gamma_{submerged} = 68$ pcf

$\phi = 38°$

$K_o = 1 - \sin\phi = 0.384$
$K = 0.95\,K_o = 0.365$

$K\gamma_{moist} = 0.365 \times 115 = 42$ psf

$K\gamma_{subm.} = 0.365 \times 68 = 25$ psf

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LATERAL EARTH PRESSURES COMPUTED R.N.M. CHECKED VT	PROJECT LOCK AND DAM No. 1 FILE No. 800 A DATE OCT. 1, 75 PAGE 2A OF ___ PAGES

MONOLITHS 8-13 UPPER GUIDE WALL AND
MONOLITHS 3-13 LOWER GUIDE WALL

These monoliths are bearing upon timber cribs

$$\gamma_{moist} = 115 \text{ pcf}$$
$$\gamma_{saturated} = 125 \text{ pcf}$$
$$\gamma_{submerged} = 63 \text{ pcf}$$

$$\phi = 35°$$

$$K_o = 1 - \sin\phi = 0.426$$
$$K = 0.85\,K_o = 0.362$$

$$K\gamma_{moist} = 0.362 \times 115 = 42 \text{ psf}$$

$$K\gamma_{subm.} = 0.362 \times 63 = 23 \text{ psf}$$

EQUIVALENT FLUID PRESSURES USED IN THE ANALYSES

Because of small variations in calculated values the following equivalent fluid weights were used for calculating earth pressures acting on the land and guide wall monoliths

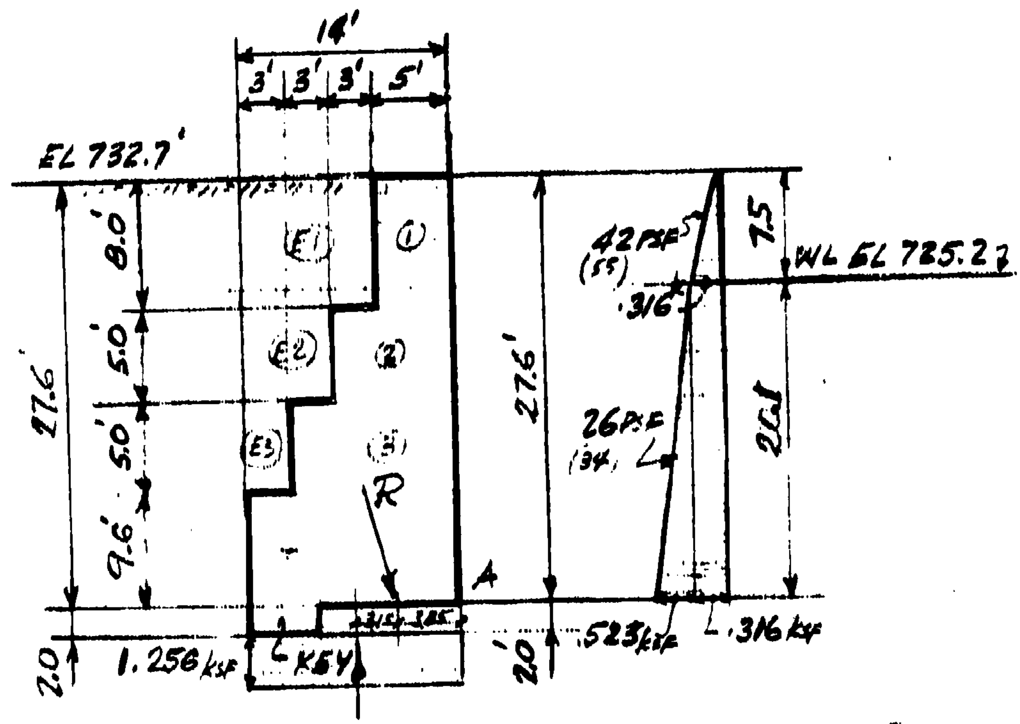
$$K\gamma_{moist} = 42 \text{ psf}$$

$$K\gamma_{submerged} = 26 \text{ psf}$$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF UPPER LAND GUIDE WALL MONO #1-7	PROJECT L&D #1
	COMPUTED M.J. CHECKED R.N.M. 4/2/75	FILE No. 800 A
		DATE 8.74 PAGE 3 OF PAGES

UPPER (LAND) GUIDE WALL MONOLITHS #1-7



$\Sigma V = 36.7^k$ $\Sigma H = 12.76^k$ $M_A = 120.3^{\,1k}$ $a = \frac{120.3}{36.7} = 3.28'$

1/. $e = 3.72$ $R = 38.9$ OUTSIDE MIDDLE $\frac{1}{3}$ BY 1.39'

2/. $\frac{\Sigma H}{\Sigma V} = \frac{12.76}{36.7} = 0.348$

3/. $f_{soil} = 7.46$ KSF (max.)

4/. $FSS = \frac{36.7 \times 0.625}{12.76} = 1.80$

5/. $FSOT = \frac{368.1}{248.6} = 1.48$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF UPPER LAND GUIDE WALL	PROJECT L&D #1
	COMPUTED M. J. CHECKED R.N.M. 4/2/74	FILE NO. 800A
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UPPER LAND GUIDE WALL - MONOLITHS #1 - #7

WATER LEVEL @ EL 725.2

LOADS IN KIPS		VERT ↓	VERT ↑	HORIZ.	HORIZ	ARM	MOM_A ↺	MOM_A ↻
C_1	8.0×5.0×.15	6.0				2.5		15.0
C_2	5.0×8.0×.15	6.0				4.0		24.0
C_3	11.0×5.0×.15	8.3				5.5		45.6
C_4	14.0×9.6×.15	20.2				7.0		141.1
E_1	.11×9.0×8.0	7.9				9.5		75.2
E_2	.13×6.0×5.0	3.9				11.0		43.0
E_3	.13×3.0×5.0	2.0				12.5		25.0
W_1	20.1×.0625×14		17.6			7.0	123.1	
Σ		54.3	17.6				123.1	368.9 ↻ 1k
H_{E_1}	$.042 \times 7.5^2/2$			1.18		22.60	26.7	
H_{E_2}	.042×7.5×20.1			6.33		10.05	63.6	
H_{E_3}	$.026 \times 20.1^2/2$			5.25		6.70	35.2	
		36.7		12.76			248.6 ↺ 1k	

$\Sigma M = 120.3$ ↻ 1k

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF UPPER LAND GUIDE WALL	PROJECT LFD #1
	COMPUTED M.J. CHECKED R.N.M. 4/2/75	FILE NO. 800 A
		DATE 8.74 PAGE 5 OF ___ PAGES

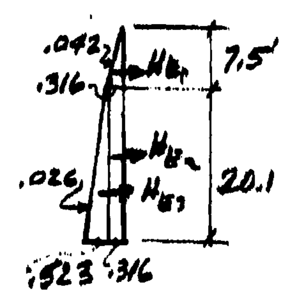
UPPER LAND GUIDE WALL - MONOLITHS #1-#7 (CONT'D)

$H_{E_1} = .042 \times 7.5^2/2 = 1.18^k \times 22.60$ ✓

$H_{E_2} = .042 \times 7.5 \times 20.1 = 6.33 \times 10.05$ ✓

$H_{E_3} = .026 \times 20.1^2/2 = 5.25 \times 6.70$ ✓

$\Sigma H = 12.76^k$



$M_{E_1} = 26.7^{\prime k}$ ✓

$M_{E_2} = 63.6$ ✓

$M_{E_3} = 35.2$ ✓

$\quad\quad 125.5^{\prime k}$ ✓

$\Sigma M = 368.9 - 125.5 - 123.1 = 120.3^{\prime k}$ ✓

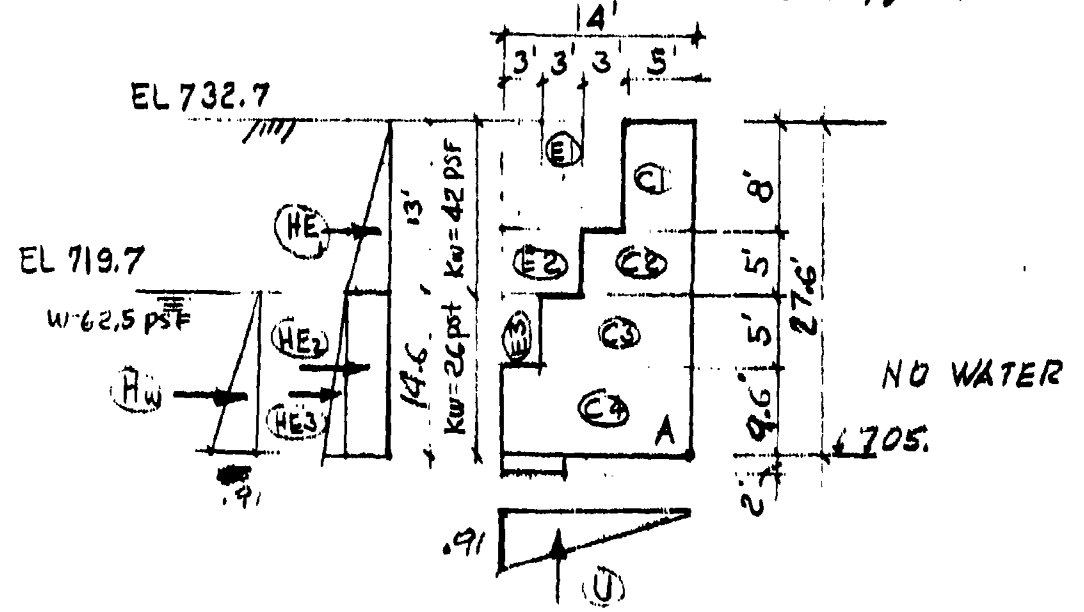
$a = \frac{120.3}{36.7} = 3.28$ ✓ $\quad f_{soil} = \frac{2}{3}\left(\frac{36.7}{3.28}\right) = 7.46$

$e = 7.0 - 3.28 = 3.72$ ✓

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT UPPER GUIDE WALL STABILITY, CONSTRUCTION CONDITION	PROJECT LOCK & DAM N 21
	COMPUTED R.N.M CHECKED JI	FILE No. 800 A
		DATE 2/'75 PAGE 5a OF PAGES

(16) STABILITY OF UPPER GUIDEWALL MONOLITHS 1-5 DURING CONSTRUCTION PERIOD.

Riverward side empty (Inside cofferdam enclosure)
Landward side W.S. EL. 719.7 (Ref. pgs 3,4 + 5)



1) "R" outside middle $\frac{1}{3}$ [redacted] by [redacted] 1.89 ft

2) $\frac{\Sigma H}{\Sigma V}$ = 0.44

3) f_{soil} = 11.34 KSF

4) FSS = 1.41

5) FSOT = 1.57

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT UPPER GUIDE WALL MONOLITHS 3,4 & 5 (CONSTRUCTION) COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM NO. 1 FILE No. 800 A DATE 2/'75 PAGE 5b OF PAGES

CONSTRUCTION CONDITION (cont'd

FORCES		H →⊕	V ↓⊕	ARM	$\overrightarrow{M_A}$	$\overleftarrow{M_A}$
C1			+ 6.0			15.0
C2			+ 6.0			24.0
C3			+ 8.3			45.6
C4			+20.2			141.1
E1			+ 7.9			75.2
E2	0.11 × 6 × 5.0		+ 3.3	11.0		36.3
E3			+ 2.0			25.0
U	14.6 × .0625 × 14 × ½		− 6.4	9.3	59.5	
HE1	$0.042(13)^2 \times \frac{1}{2}$	+ 3.5		18.9	66.2	
HE2	0.042(13) × 14.6	+ 8.0		7.3	58.4	
HE3	$0.026(14.6)^2 \times \frac{1}{2}$	+ 2.8		4.9	13.7	
HW	$0.0625(14.6)^2 \times \frac{1}{2}$	+ 6.7		4.9	32.8	
		ΣH = 21.0	ΣV = 47.3		230.6	362.2
					ΣM_A =	131.6

$\bar{x} = \frac{131.6}{47.3} = \underline{\underline{2.78}}$ $e = 7 - \bar{x} = \underline{\underline{4.22'}}$ $\frac{L}{6} = 2.33$

(1) Resultant outside middle $\frac{1}{3}$, 1.89'

(2) $f_{soil} = \frac{2}{3}\frac{\Sigma V}{\bar{x}} = \frac{2}{3} \times \frac{47.3}{2.78} = 11.34$ KSF

(3) $\frac{\Sigma H}{\Sigma V} = \frac{21.0}{47.3} = 0.44$

(4) FSS = $\underline{1.41}$

(5) FSOT = $\frac{362.2}{230.6} = \underline{1.57}$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF UPPER LAND GUIDE WALL	PROJECT L & D #1
	COMPUTED M. J. CHECKED R.N.M.	FILE No. 800A
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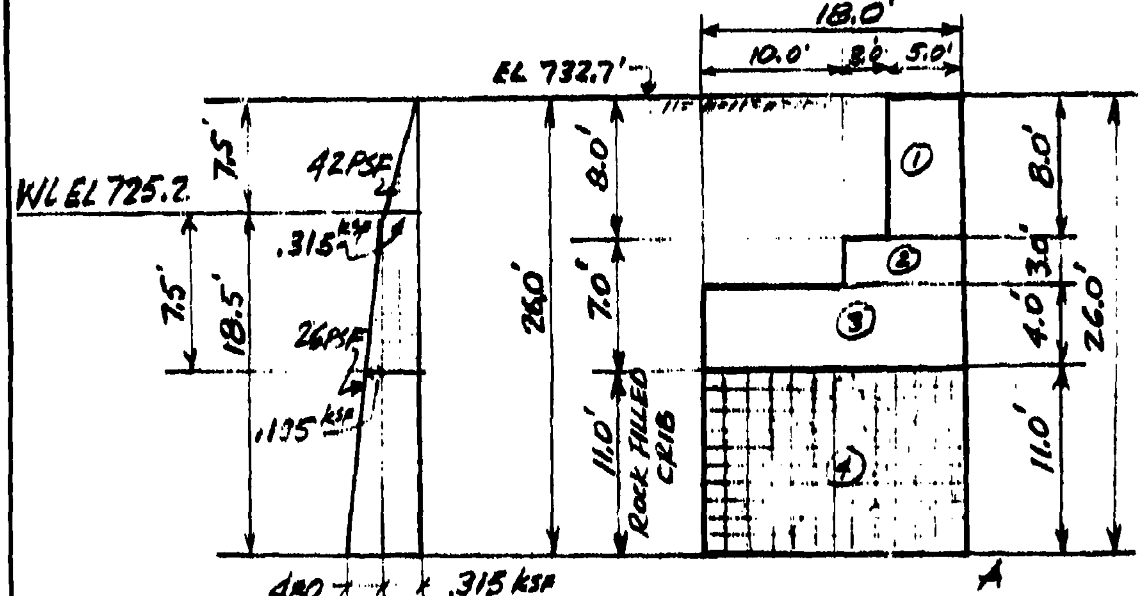
UPPER (LAND) GUIDE WALL - MONOLITHS #8-13



$\Sigma V = 34.70^k \quad \Sigma H = 11.40^k$

$M_A = 194.0^{'k} \quad a = \frac{194.0}{34.70} = 5.60' \quad e = 3.4'$

1). $R = 37.8^k$ OUTSIDE MIDDLE $\frac{1}{3}$ BY 0.4'

2). $\frac{\Sigma H}{\Sigma V} = .33 \ (<.417 \ ok)$

3). $FSS = \frac{34.7 \times .625}{11.40} = 1.90$

4). $f_{soil} = 4.13$ ksf

5). FSOT = 2.06

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF UPPER LAND GUIDE WALLS COMPUTED M.J. CHECKED R.N.M.	PROJECT LFD #1 FILE No 800A DATE 8.74 PAGE 7 OF PAGES

UPPER LAND GUIDE WALL - MONOLITHS #8-13

	LOADS IN KIPS	VERT ↓	VERT ↑	HORIZ. →	HORIZ. ←	ARM	MOM_A ↻	MOM_A ↺
C_1	8.0×5.0×.15	6.0				2.5		15.0
C_2	8.0×3.0×.15	3.6				4.0		14.6
C_3	18.0×4.0×.15	10.8				9.0		97.2
C_4	18.0×11.0×(.10-.063) .037	7.4				9.0		66.6
E_1	13.0×8.0×.11	11.5				11.5		132.3
E_2	3.0×10.0×.13	3.9				13.0		50.8
W_1	7.5×.0625×18.0		8.5			9.0	76.5	
H_{E1}	.315×3.75			1.2		21.0	25.3	
H_{E2}	.315×18.5			5.8		9.25	53.6	
H_{E3}	.48×18.5/2			4.4		6.17	27.2	
		43.2	8.5	11.4			182.6	376.5

$\Sigma V = 43.2 - 8.5 = 34.7^k$

$\Sigma M = 376.5 - 182.6 = 194.0^{'k}$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF UPPER GUIDE WALLS COMPUTED M.J. CHECKED R.N.M.	PROJECT LFD #1 FILE No 900A DATE 8.74 PAGE 8 OF ___ PAGES

UPPER LAND GUIDE WALL - MONOLITHS #8-#13

$\Sigma V = 34.70^k$

$\Sigma H = 11.40^k$

$\Sigma M = 194.0$

$a = \frac{194.0}{34.70} = 5.60$

$e = 9.0 - 5.6 = 3.4$

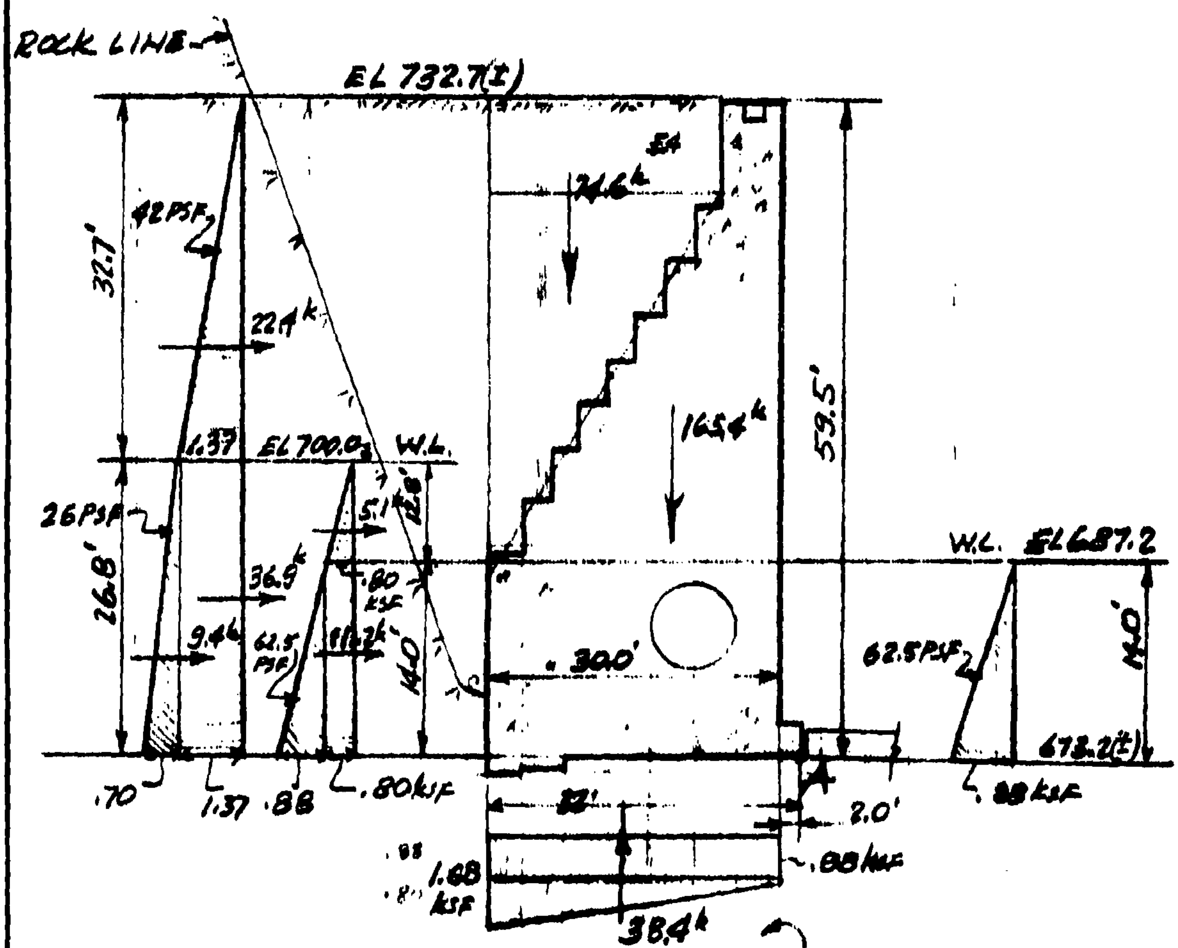
$Me = 34.70 \times 3.4 = 118.0^{'k}$

1. RESULTANT OUTSIDE MIDDLE THIRD BY 0.4'
2. $\frac{\Sigma H}{\Sigma V} = \frac{11.40}{34.70} = .33$
3. $FSS = \frac{34.70 \times .625}{11.40} = 1.90$
4. $f_{SOIL} = \frac{2}{3} \times 34.70 / 5.6 = 4.13$ KSF
5. $FSOT = \frac{376.5}{182.6} = 2.06$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT L & D #1
		FILE No 800 A
	COMPUTED M.J. CHECKED R.N.M.	DATE 1974 PAGE 9 OF ___ PAGES

W.S. EL. 700' (LANDWARD)

LANDWALL MONOLITHS #5-15 - EXISTING CONDITION



$\Sigma V = 202.0^k$ $\Sigma H = 85.0^k$ $\Sigma M_A = 1647.0'^k$

1). $R = 218.0^k$ OUTSIDE MIDDLE $\frac{1}{3}$ BY 2.52

2). $\frac{\Sigma H}{\Sigma V} = .422$

3). $f_{SOIL} = 16.5\ ksf$

4). $FSS = \frac{202.0 \times .625}{85.0} = 1.49$

5). $FSOT = 1.68$

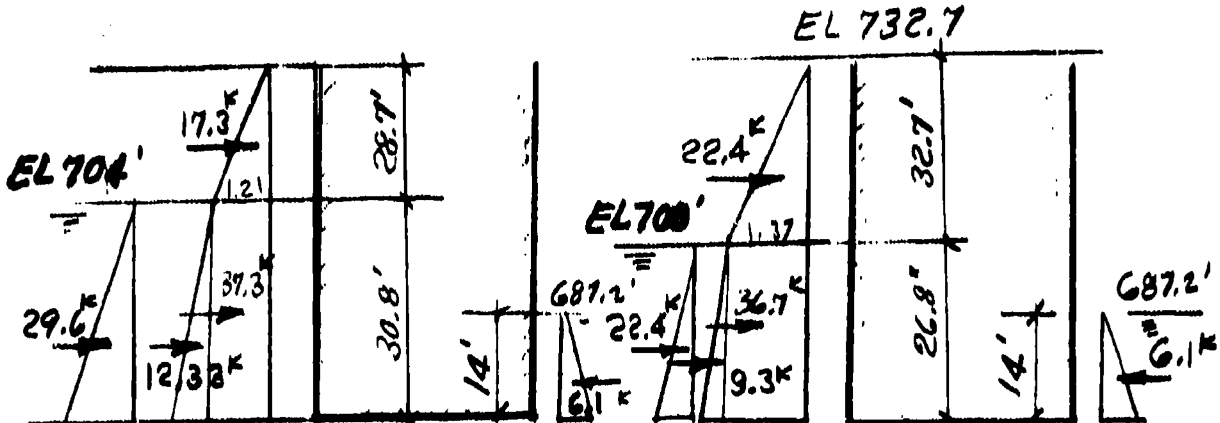
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL 5[illegible]-15 EXISTING – NORMAL COMPUTED R.N.M. CHECKED J.I.	PROJECT L & D #1 FILE No. 800 A DATE 1/'75 PAGE 10 OF ___ PAGES

W.S. EL 704' (LANDWARD)

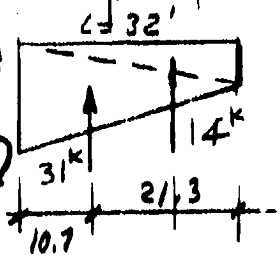
LANDWALL MONOLITHS ^{5} -15
NORMAL OPERATING, EXISTING CONDITION

Added hor. force — friction from wt. of submerged slab, $P_R = 2 \times 56 \times .088 \times .55 = 5^k \leftarrow$

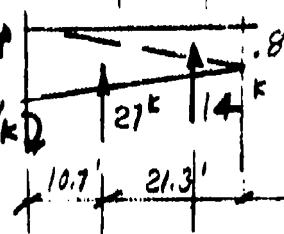
Compute difference in earth + hydrostatic pressures:



$31 + 14 = 45^k \uparrow$
$\times 21.3 \quad \times 10.7$
$660 + 150 = 810'^k$



$27 + 14 = 41^k \uparrow$
$\times 21.3 \quad \times 10.7$
$575 \quad 150 = 725'^k$



$$\Sigma H_{704} = 17.3 + 37.3 + 12.33 + 29.6 - 6.1 = 90.4^k \rightarrow$$
$$\times 40.4 \quad \times 15.4 \quad \times 10.3 \quad \times 10.3 \quad \times 4.9$$
$$\Sigma M_{A\,704} = 700 + 574 + 127 + 305 - 29 + 810 = 2487'^k$$

$$\Sigma H_{700} = 22.4 + 36.7 + 9.3 + 22.4 - 6.1 = 84.7^k \rightarrow$$
$$\times 37.7 \quad \times 13.4 \quad \times 8.9 \quad \times 8.9 \quad \times 4.9$$
$$\Sigma M_{A\,700} = 844 + 492 + 83 + 199 - 29 + 725 = 2314'^k$$

$$\Delta H = 90.4 - 84.7 - 5 = 0.7^k \rightarrow$$
$$\Delta V = 45 - 41 = 4^k \uparrow$$
$$\Delta M_A = 2487 - 2314 = 173'^k$$

Cont'd on Pg 10 & 2

W.S. EL. 704'

LANDWALL MONOLITHS 5-15
NORMAL OPERATING, EXISTING CONDITION (CONT'D)

From page 11, $\Sigma H' = 85^k \rightarrow$, $\Sigma V' = 202^k \downarrow$, $\Sigma M_A' = 1647'^k$ } For W.S. EL 704, without Pr

$\Sigma H = 85 + .7 = 85.7^k$

$\Sigma V = 202 + (-4) = \underline{198}^k$

$\Sigma M_A = -1647 + 173 = -1474\ k$

(1) $a = \frac{1474}{198} = 7.44'$ $e = \frac{L}{2} - a = 8.56$
$-\underline{5.33} \cdots L/6$

Location of Resultant 3.23' Outside middle 3rd.

(2) $\frac{\Sigma H}{\Sigma V} = \frac{85.7}{198} = 0.43$

(3) $FSS = \frac{198 \times .625}{85.7} = \underline{1.44}$

(4) $f_{soil} = \frac{2}{3} \times \frac{198}{7.44} = 17.74$ KSF

(5) $FSOT = \frac{4051}{2404 + 173} = 1.57$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS COMPUTED M. J. CHECKED R.N.M.	PROJECT LED #1 FILE NO. 800A DATE 11.74 PAGE 11 OF PAGES

W. S. EL. 700' (LANDWARD)

LANDWALL MONOLITHS #5-15-EXISTING CONDITION

$E_4 = 24.0 \times 7.5 \times .13 = 23.40^k$ (REF: CASE FOR LOWERING BACKFILL BY 10.0')

$\Sigma V = 202.0^k$ (222.8 - 44.6 + 23.4)

$\Sigma H = 85.0$

$\Sigma M_A = 3583.5 - 808.0 + 23.40 \times 20.0 - 1596 = 4051 - 2404$

$\Sigma M_A = 1647.0^{'k}$

$a = \frac{1647.0}{202.0} = 8.15'$

$e = 16.0 - 8.15 = 7.85'$

1). RESULTANT $R = 218.0^k$ OUTSIDE MIDDLE $\frac{1}{3}$ BY 2.52'

2). $\frac{\Sigma H}{\Sigma V} = \frac{85.0}{202.0} = 0.422$

3). $f_{SOIL} = \frac{2}{3} \times 202.0 / 8.15 = 16.50$ ksf

4). $FSS = \frac{202.0 \times .625}{850} = 1.49$

5). $FSOT = \frac{4051}{2404} = 1.68$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL 5-15 EXISTING - MAINTENANCE	PROJECT LOCK & DAM #1
	COMPUTED R.N.M CHECKED JI	FILE No. 800 A
		DATE 3/'75 PAGE 12 OF ___ PAGES

W.S. EL 704 (LANDWARD)

LANDWALL MONOLITHS 5-15

MAINTENANCE LOADING — LOCK EMPTY
— EXISTING BACKFILL @ EL 732.7
— (REFER TO NORMAL LOADING)
— FRICTION BETWEEN SLAB & ROCK

REFERENCE PAGES 10 & 10a

$\Sigma H = 91 + 6.8 = \underline{97.8}$ kips →

$\Sigma V = 198 + 14 = \underline{212.0}$ kips ↓

$\Sigma M_A = -1473 + (-150) + 33 \} = -\underline{1590}$ 'k ↻

(1) $a = \dfrac{1590}{212} = 7.5'$. $\dfrac{L}{2} - a = e = \underline{8.5}'$

. "R" OUTSIDE M 1/3 ; $\underline{3.2}$ H.

(2) $\dfrac{\Sigma H}{\Sigma V} = \dfrac{97.8}{212} = \underline{0.46}$

(3) FSS $= \underline{1.35}$

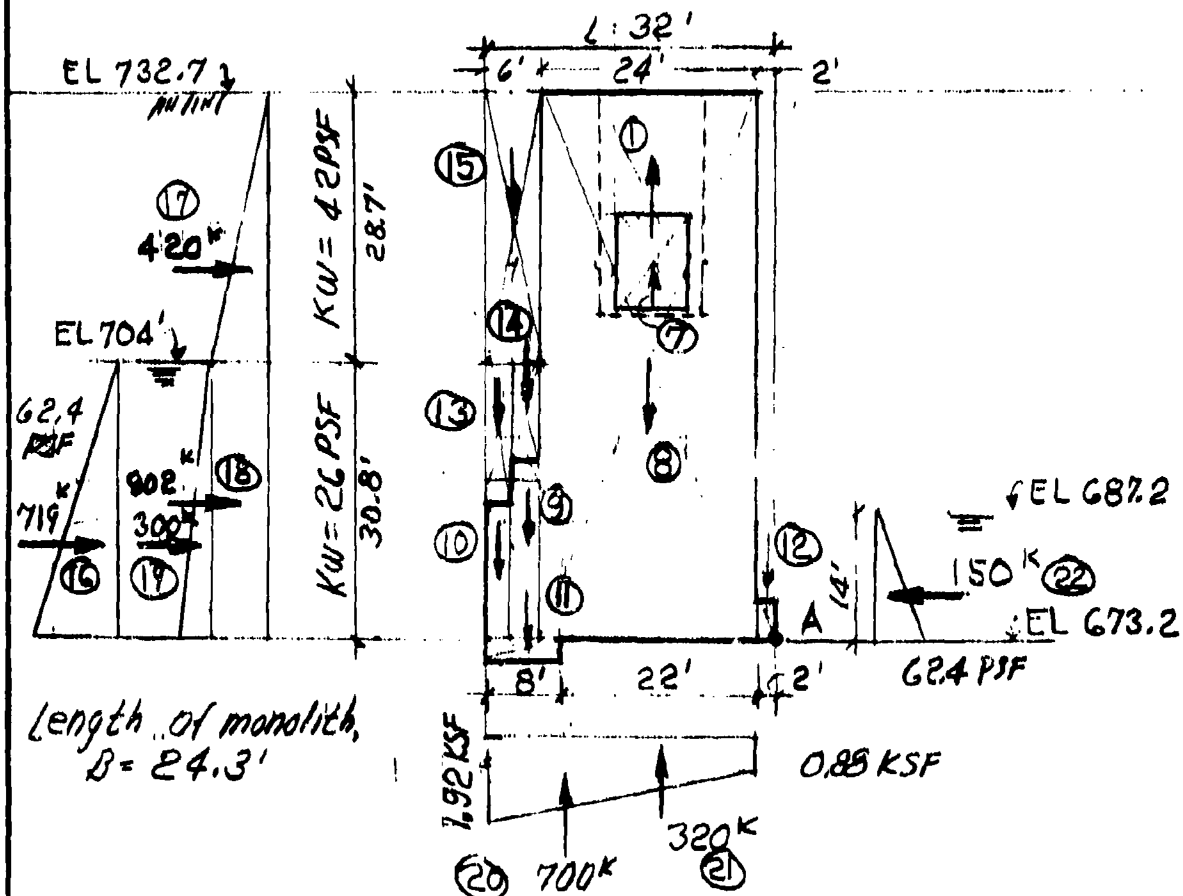
(4) $f_{soil} = \dfrac{2}{3} \times \dfrac{212}{7.5} = \underline{18.84}$ KSF

(5) FSOT $= \dfrac{4051}{2578+150-33} = \underline{1.5}$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY- EXISTING CONDITION	PROJECT LOCK & DAM NO. 1
	COMPUTED R. N. M. CHECKED J.L.	FILE No 800 A
		DATE 2/'75 PAGE 10 a OF PAGES

MONOLITH NO. 3, NORMAL LOADING CASE (PRESENT)



(1) Resultant 3.73 ft. outside middle ⅓

(2) $f_{soil} = 13.41$ KSF

(3) $\frac{\Sigma H}{\Sigma V} = 0.461$

(4) FSS = 1.36

(5) F.S.O.T. = 1.54

FOR USE ON U.S. GOVERNMENT WORK ONLY 18

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY - EXISTING CONDITION COMPUTED R.N.M. CHECKED J.L.	PROJECT LOCK & DAM NO. 1 FILE NO. 800 A DATE 2/'75 PAGE 10b OF ___ PAGES

MONOLITH NO. 3, NORMAL LOADING CASE (CONT'D)

		H →(+)	V ↓ (+)	ARM	M_{Y-Y}
17	$(28.7^2/2)\,.042\,(24.3)$	420		40.4	+16981
18	$28.7 \times 0.042 \times 30.8 \times 24.3$	902		15.4	+13893
1	$14 \times 14 \times 24\,(-0.15)$		−706	2	+1412
7	$11.5 \times 11 \times 9\,(-0.15)$		−170	2	−340
8 TO 12	"FR. TEMP. CONST."		+5641	(0.93)	+5237
15	$6 \times 28.7 \times 24.3 \times 0.11$		+460	13'	−5980
13 & 14	FROM TEMP. CONST.		+261		−3463
16 and 19	FR. TEMP. CONST.	+1019			+10496
Pn	$2 \times 56 \times 0.088 \times 24.3 \times .55$	−132	—	—	—
20	$1.92 \times 30 \times \frac{1}{2} \times 24.3$		−700	6'	+4200
21	$0.88 \times 30 \times \frac{1}{2} \times 24.3$		−320	4	−1280
22	$14^2 \times \frac{1}{2} \times 0.0625 \times 24.3$	−150		4.67	−700

5486

$\Sigma H = +2059$ $\Sigma M_{Y-Y} = +40456$

$\Sigma V = 4466^K$

$e = \frac{40456}{4466} = 9.06 > \frac{L}{6}$, $\frac{5.33}{9.06}$ $\bar{X} = 6.94$

(1) RESULTANT IS 3.73 OUTSIDE MIDDLE 3rd

(2) $f = \frac{2}{3}\frac{\Sigma V}{A} = \frac{2}{3}\frac{4466}{6.94 \times 32} = 13.41\ KSF$

(3) $\frac{\Sigma H}{\Sigma V} = \frac{2059}{4466} = 0.461$

40456 − 43590 = −3134

$\frac{3134}{5486} = 0.57$ 16.00

(4) FSS = $\frac{625}{461}$ = 1.36 RESIST. $M_A = 5486 \times 16.57 = 90903$

(5) F.S.O.T. = 1.54 OVERT. $M_A = 48590 - 2980 + 320 \times \frac{22}{3} + 700 \times \frac{2}{3} \times 32 = 59017'^K$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LAND WALL STABILITY – TEMPORARY CONSTRUCTION COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM # 1 FILE No. 800 A DATE 2/'75 PAGE 10C OF ___ PAGES

LANDWALL MONOLITH NO. 3
REHABILITATION – ALL PLANS

RESULTS:

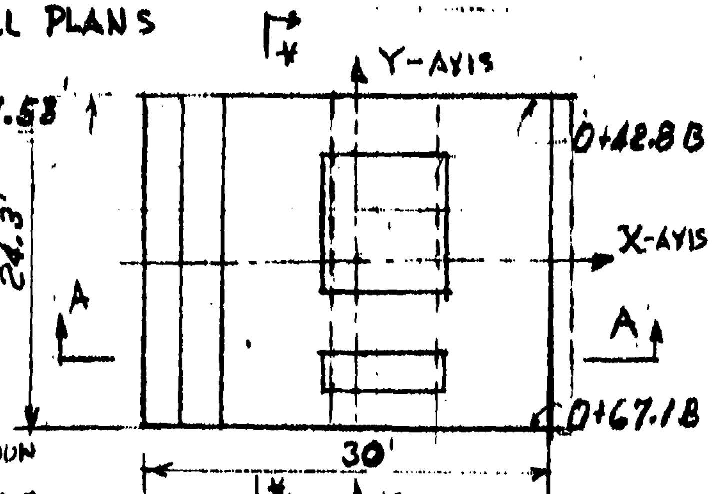
1) "R" outside mid $\frac{1}{3}$ by 1.58'

2) f_{soil} = 12.5 KSF

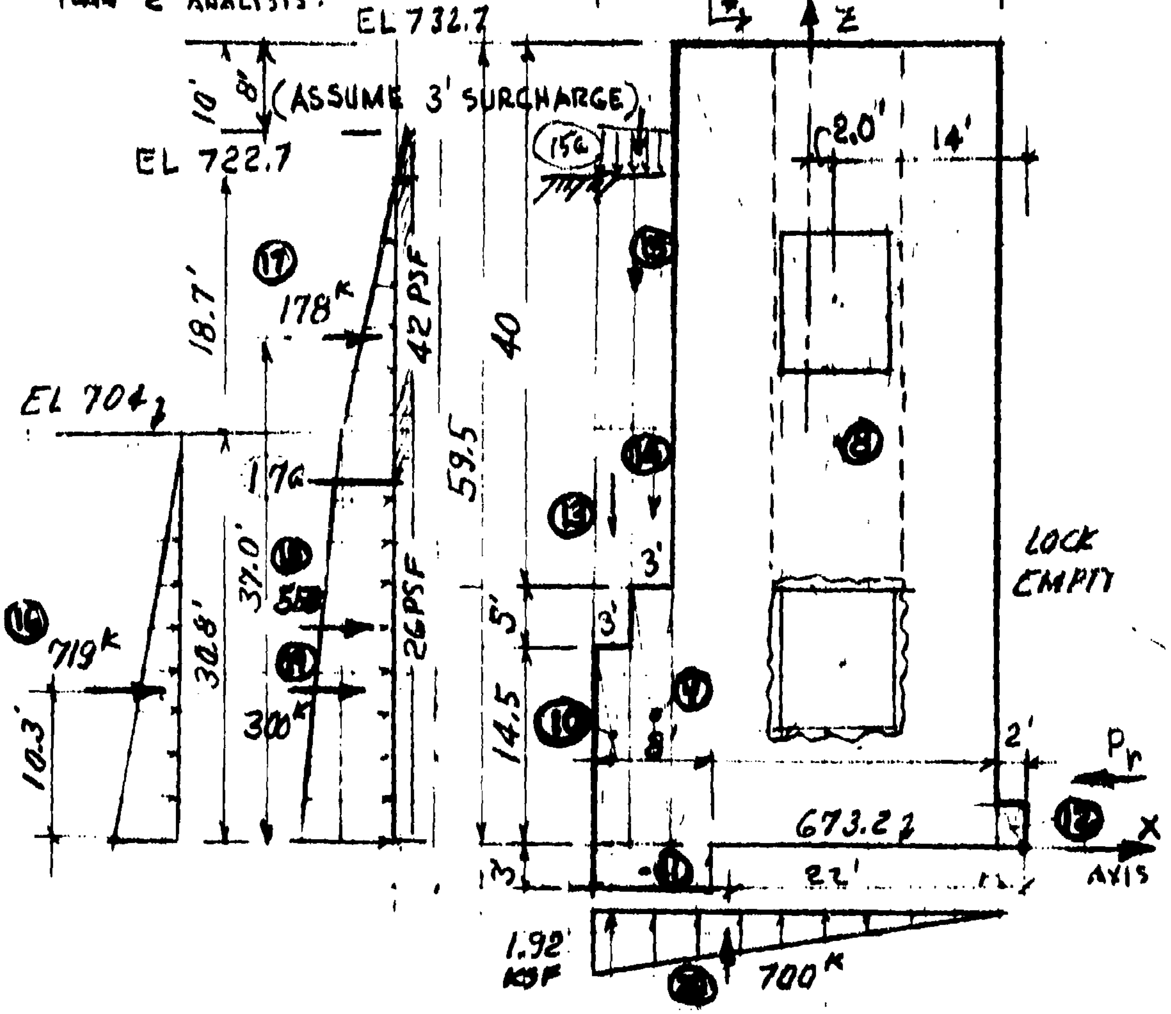
3) $\frac{\Sigma H}{\Sigma V}$ = 0.436

4) FSS = 1.43

5) FSOT = 2.10



* SEE RIVERWALL MONOLITH #4 REHABILITATION PLAN 2 ANALYSIS.



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY - TEMPORARY CONSTRUCTION COMPUTED R.N.M. CHECKED JI	PROJECT LOCK & DAM NO. 1 FILE NO 800 A DATE 2/75 PAGE 10d OF ___ PAGES

LANDWALL MONOLITH NO. 3

REHABILITATION - ALL PLANS (con'd)

		H → (+)	V ↓ (+)	ARM	M_Y (+)
1 To 7	See intermediate wall monolith No. , Rehabilitation Plan 2 Analysis		-1386	2.0	-2772
8	59.5 x 24 x 24.3 x 0.15		5205	2.0	+10410
9	19.5 x 3 x 24.3 x 0.15		213	11.5	-2450
10	14.5 x 3 x 24.3 x 0.15		159	14.5	-2306
11	8 x 3 x 24.3 x .088		51	12.0	612
12	2 x 3 x 24.3 x .088		13	15.0	+195
13	16.3 x 3 x 24.3 x .13		154	14.5	-2233
14	11.3 x 3 x 24.3 x .13		107	11.5	-1230
15	18.7 x 6 x 24.3 x .11		300	13.0	-3900
15a	3.0 x 6.0 x 24.3 x 0.11		48	13.0	-625
			4864	1.14	5525
17a	2 x .042 x 50 x 24.3	+102		25	+2552
16	$30.8^2 \times \frac{1}{2} \times .0624 \times 24.3$	+719		10.3	+7406
17	$18.7^2 \times \frac{1}{2} \times .042 \times 24.3$	+178		37.0	+6586
18	18.7 x .042 x 30.9 x 24.3	+588		15.4	+9055
19	$30.9^2 \times \frac{1}{2} \times .026 \times 24.3$	+300		10.3	+3010
H_S	.042 x 3 x 49.5 x 24.3	+152		24.8	+3770
P_P*	2 x 56 x 0.15 x 24.3 x .55	-224		—	—
20	$1.92 \times 30 \times \frac{1}{2} \times 24.3$		-700	6.0	+4200
		+1815 k + ~~1713~~	+4164		31136 + ~~20584~~

5205 + 5937 = 5932 ; +1774 ; +5237 ; -3463 ; 1788

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY – TEMPORARY CONSTRUCTION	PROJECT LOCK & DAM NO. 1
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LANDWALL MONOLITH NO. 3
REHABILITATION - ALL PLANS (CONT'D)

$$\Sigma H = \overset{1815}{\cancel{1718}}{}^{k} \qquad \Sigma V = 4164^{k} \qquad \Sigma M_{\gamma} = \overset{31136}{\cancel{28584}}\ {}'^{k}$$

(1) $e_{\gamma} = \dfrac{\overset{31136}{\cancel{28584}}}{4164} = \overset{7.47'}{\cancel{6.86}}$

$\dfrac{L}{6} = \dfrac{5.33}{\overset{2.14}{\cancel{1.53}}}$

Resultant, outside middle $\frac{1}{3}$

(2) $\bar{X} = \frac{L}{2} - e = \overset{8.53'}{\cancel{9.14}}$

$f_{soil} = \dfrac{2}{3} \times \dfrac{4164}{24.3 \times \overset{8.53}{\cancel{9.14}}} = \overset{13.39}{\cancel{12.5}}$ KSF

(3) $\dfrac{\Sigma H}{\Sigma V} = \dfrac{\overset{1815}{\cancel{1718}}}{4164} = 0.436$

(4) FSS = 1.43

(5) ΣM_A (Resisting) = 4864 (7.14 + 16) = 83369 'k

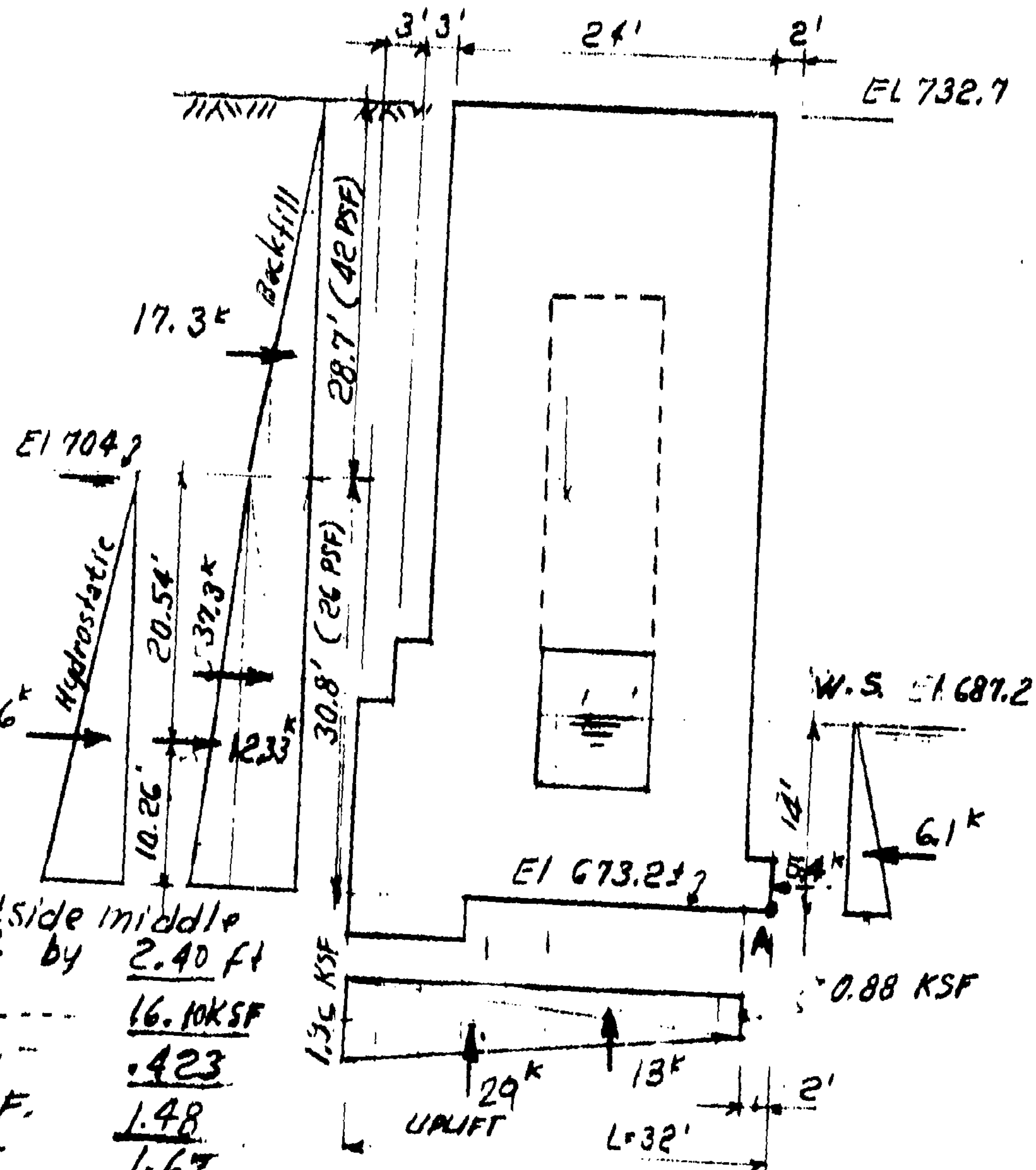
ΣM_A (Overturning) = 24384 + [illegible] + 2552 = ~~39784~~ 'k
42336 'k

$$FSOT = \frac{83369}{\overset{42336}{\cancel{39784}}} = \overset{1.97}{\cancel{2.10}}$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY - EXISTING CONDITION COMPUTED R. N. M. CHECKED JI	PROJECT LOCK & DAM No 1 FILE No. 800A DATE 3/'75 PAGE 10K OF ___ PAGES

MONOLITH No 3
NORMAL LOADING
(WITHOUT STABILIZATION)

CONDUIT IS LOWERED AND 2 GATE SHAFTS ARE FILLED WITH CONCRETE



1) R outside middle $\frac{1}{3}$ by 2.40 ft
2) f_{soil} ---- 16.10 KSF
3) EH/EV -- .423
4) S.S.F. 1.48
5) F.S.O.T. 1.67

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MONOLITH NO. 3
NORMAL LOADING (CONT'D)

This page is refered to: a) Pg 10a, for Hydrostatic and earth pressures
b) Pg 35c, for completed 8'x10' conduit geometry.
c) Pg 10c, for Dead load

(Analyzed per foot strip of wall)

Forces	H (+ →)	V (↓ +)	ARM	M_A
Net horizontal ----	90.4^k			$2468^{'k}$
Uplift --------		-29^k	22.0	
		-13^k	12.0	
Water in lower conduit: $10 \times 6 \times 8 \times .0625 \times \frac{1}{24.3}$		$+2^k$	14.0	$-28^{'k}$
10'x8' Conduit space: Approx. length = 37' $80 \times 37 \times (-0.15) = 444^k$ Equiv. per foot = $\frac{444}{24.3}$ =		-19^k	14.0'	$+266^{'k}$
Dead load: (8) to (14) = $\frac{5641+261}{24.3}$		$+243^k$	15.7' *	$-3815^{'k}$
(15) $28.7 \times 6 \times .11$		$+19^k$	29.0'	$-551^{'k}$
P_R	-5.4^k			
Σ's	85^k	201^k		

$M_{RE} = -4128^{'k}$

$M_{OV} = 2468$

$\Sigma M_A = -1660^{'k}$

* $\frac{1774}{5902}$ (M_y) $= 0.3'$ from ℄

Arm = 16 - .3 = 15.7

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MONOLIT No 3

NORMAL LOADING (CONT'D)

$\Sigma H = \underline{85}\ ^{k} \rightarrow$ $\qquad l = 32'$ $\qquad \frac{L}{6} = 5.33'$

$\Sigma V = \underline{201}\ ^{k} \downarrow$

$\Sigma M_A = \underline{1660}\ 'k$ $\qquad B = 1'$

$$a = \frac{\Sigma M_A}{\Sigma V} = \underline{8.30'}; \quad e = \frac{L}{2} - a = \underline{7.70}$$

(1) Resultant is outside the middle 1/3 by 2.40 feet

(2) $f_{soil} = \frac{2}{3}\frac{\Sigma V}{a} = \frac{2}{3}\frac{201}{8.3} = \underline{16.10}$ KSF

(3) $\frac{\Sigma H}{\Sigma V} = \frac{85}{201} = 0.\underline{423}$

(4) $SSF = \frac{0.625}{\Sigma H/\Sigma V} = \underline{1.48}$

(5) $F.S.O.T. = \frac{M_{Re}}{M_{ov}} = \frac{4128}{2468} = \underline{1.67}$

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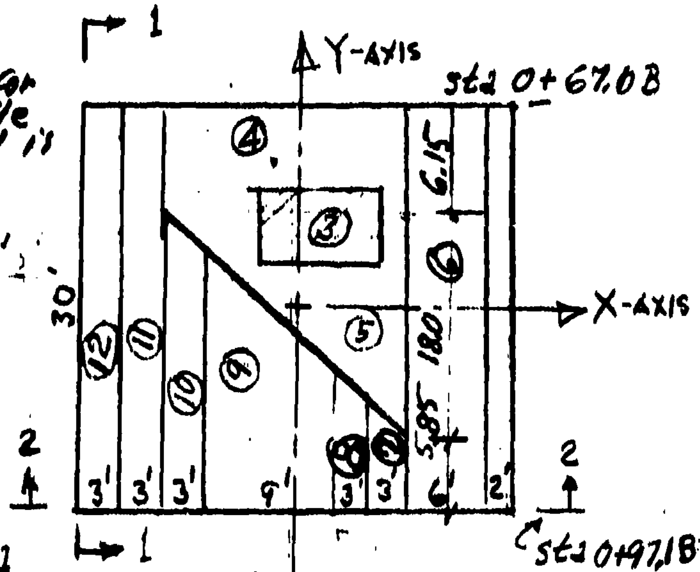
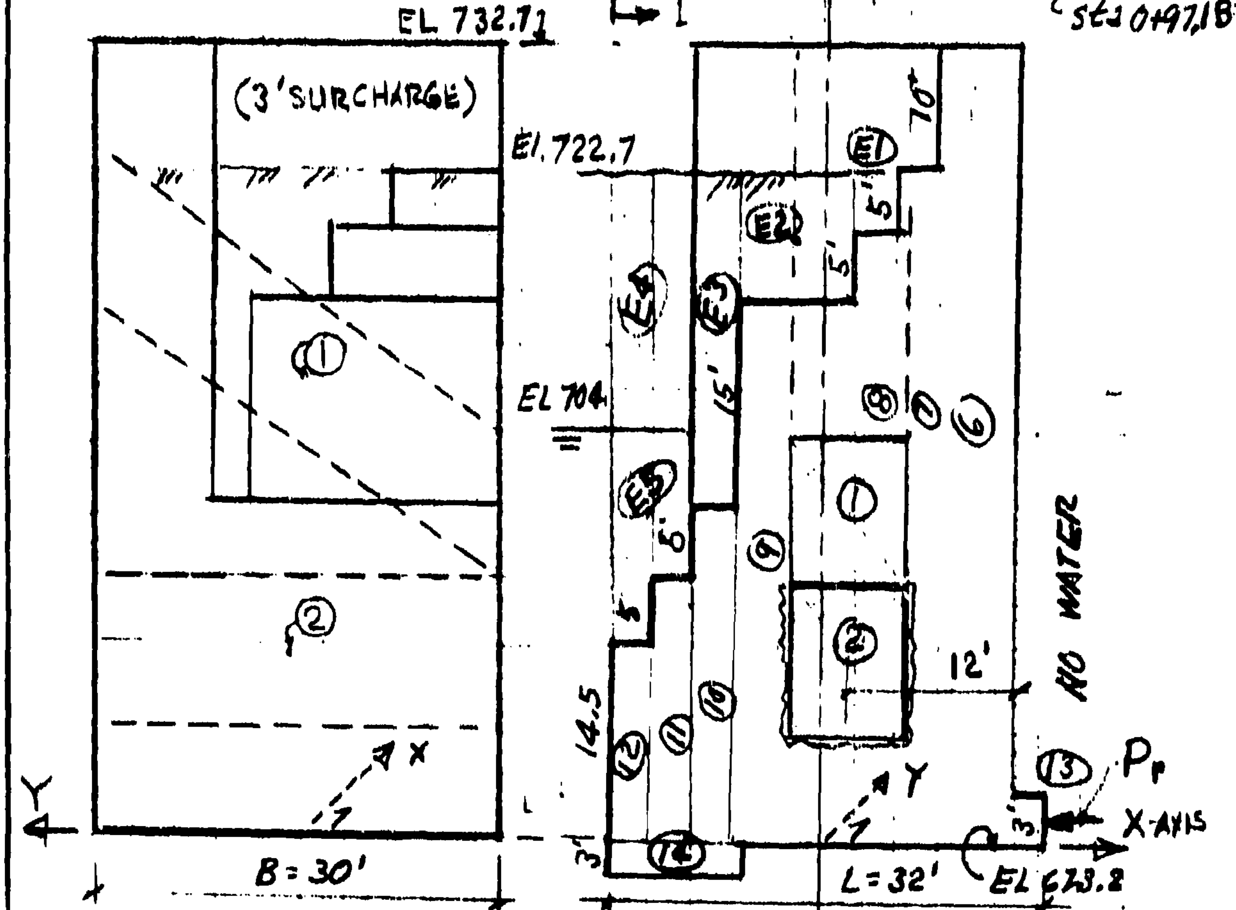
LANDWALL MONOLITH NO. 4
REHABILITATION - ALL PLANS

Assumptions: Conc. removed for new tunnel while existing tunnel is still unplugged. Lock empty.

Results ;

1) "R" outside middle 1/3, 2.4'
2) f = 13.4 KSF
3) $\frac{\Sigma H}{\Sigma V}$ = 0.41
4) F.S.S. = 1.52
5) F.S.O.T. = 1.79





SECT. 1-1 SECT. 2-2

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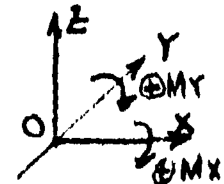
LANDWALL MONOLITH NO. 4
REHABILITATION – ALL PLANS
(CONT'D)

	Concrete and soil	H	V	Y	X	Mx	∑My
1	11×9×35×(-0.15)		-520	0	+2.0	—	-1040
2	11×9×30 (-0.15)		-446	0	+2.0		-892
3	10×5×40 (-0.15)		-300	+5.5	+2.0	+1650	-600
			1266			1650	2532
4	18×6.15×59.5×0.15		+988	+12.0	-1.0	-11856	-988
5	18×18×½×59.5(0.15		+1446	+2.85	+2.0	-4121	+2892
6	6×30×59.5(0.15		+1607	0	+11.0	-0	+17677
7	3×7.35×49.5×0.15		+164	-11.3	+6.5	+1853	+1066
8	3×10.35×44.5×0.15		+207	-10.-	+3.5	+1925	+725
9	9×16.35×39.5×0.15		+872	-7.5	-2.5	+6540	-2180
10	3×22.35×24.5×0.15		+246	-4.0	-8.5	+984	-2091
11	3×30×19.5×0.15		+263	0	-11.5	—	-3025
12	3×30×14.5×0.15		+196	0	-14.5	—	-2842
13	2×3×30×(0.089)		+16	0	+15.0	—	+240
14	8×3×30 (0.089)		+64	0	-12.0	—	-768
			6069			2675	-10706
E1	3×5×10.35×0.11		+17	-10.0	+3.5	+167	+60
E2	9×10×16.35×0.11		+162	-7.5	-2.5	+1215	-405
E3	3×25×22.35×0.11		+184	-4.0	-8.5	+736	-1564
E4	6×30×18.7×0.11		+370	0	-13.0	—	-810
E5	6×18.8×30×0.13		+328	0	-13.0	—	-199
			1056			2118	-1091
S1	3.0×6.0×30.×.11		+59	0	-13.-	—	-767
S2	3.0×18×18×½×.11		+53	-3.16	-4.-	+167	-212
S3	3×6×24.×.11		+46	-12.08	-1.0	+556	-46
			+158			+723	-1025
			+6017			-184	-3769

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY - TEMPORARY CONSTRUCTION COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM #1 FILE No 800 A DATE 2/'75 PAGE 10k OF ___ PAGES

LANDWALL MONOLITH NO. 4
REHABILITATION - ALL PLANS (Cont'd)



Soil pressure, Hydrostatic Uplift and Surcharge	H	V ↓⊕	ARM	Mx	My
Carried fr. preceeding pg.		#6017		-184	-3769
(16) $719 \times \frac{30}{24.3}$	+888		10.3	—	+9146
(17) $178 \times \frac{30}{24.3}$	+220		37.0	—	+8140
(18) $588 \times \frac{30}{24.3}$	+726		15.4	—	+11180
(19) $300 \times \frac{30}{24.3}$	+370		10.3	—	+3811
(20) $700 \times \frac{30}{24.3}$		-864	6.0	—	+5184
(21) $152 \times \frac{30}{24.3}$	+188		24.8	—	+4662
(22) Reaction in 2' slab (See page ——)	-277	—	—	—	—

See Rehabilitation, all plans, Mon. #3

32277

ΣH 2115 $\quad \Sigma M_x = -184$

$\Sigma V = 5153 \quad \Sigma M_Y = +38354$

$e_x = \frac{38354}{5153} = 7.44'$

$5153 \quad 5.33 = L/6$

$R = 2.11'$ outside the middle third $\quad \frac{e_x}{32} = 0.23$

$e_y = \frac{-184}{5153} = +0.04''$ $\quad \frac{e_x}{30} = 0.401$ $\quad K = 2.5$

$f_{soil} = \frac{2.5 \times 5153}{30 \times 32} = 13.4$ KSF

$\frac{\Sigma H}{\Sigma V} = \frac{2115}{5153}$ 0.41

SSF = 1.52

$\Sigma M_R = \left(\frac{3761}{6017} + 16\right) \frac{6017}{5573} = 100047$

$\Sigma M_{overt} = 32277 + 864 \times 22 + 4662 = 55947$

FSOT = 1.79

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LANDWALL MONOLITH NO. 4 - REHABILITATION, ALL PLANS (cont'd)

FRICTION RESISTANCE FROM WEIGHT OF LANDLOCK SLAB

It is assumed that the 2' thick slab in landward lock is capable of supporting a transverse load, P_r, equal to the force of friction between slab and foundation derived from its own weight.

$$P_r = 2 \times 56 \times 0.15 \times 0.625 = 10.5^k \text{ per foot}$$

P_r is resisted by uniformly distributed frictional force and becomes zero at end of 56' slab. Actually, buckling is not possible because any moment developed from eccentricity between P_r + friction is overcomed by wt. of slab.

SSF FOR GROUND WATER BEHIND WALL @ EL 700.

2165 5153

+ 91

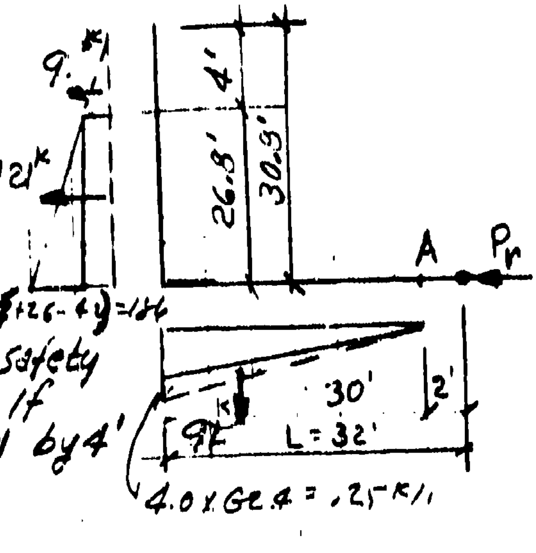
−9 ΣV = 5244^K

−121

ΣH 1985^K

$\frac{\Sigma H}{\Sigma V}$ = 0.38

SSF = 1.64 ← Factor of safety against sliding if W.S. is lowered by 4'



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILITY- EXISTING CONDITION COMPUTED R.N.M. CHECKED J	PROJECT LOCK & DAM # 1 FILE No. 800A DATE 3/'75 PAGE 10 n OF ___ PAGES

MONOLITH No 4
NORMAL LOADING
(WITHOUT STABILIZATION)

CONDUIT IS LOWERED
2 NEW GATE SHAFTS
FULL OR UNIFORM CONCRETE SECTION (24' TOP WIDTH)

This case is referred to monolith 3, Lowered conduits existing, normal loading condition on pages 10 k to 10 m.
The same outside geometry and loading prevails except that now, conduit is shorter and that, 2 gate shafts are added. Another assumption is that the monolith is filled with concrete to the shape of monolith 3

Wt. of conduit space removed for monolith 3 (+) plus water (-) $= +19 - 2 = +17^{k} \downarrow$

Wt. of conduit space for monolith 4

Void $= -8 \times 4 \times 1 \times .15$ ---------- $-12.^{k}$

water $= +8 \times 10 \times 1 \times .0625$ - $+3.0$

service gate shaft :

$\frac{7 \times 9 \times 40 \times (-0.15)}{30}$ (See 35 f) --- -12.6^{k}

maintenance gate shaft

$\frac{3 \times 9 \times 40 \times (-0.15)}{30}$ ---------- $\underline{-5.4^{k}}$

$\Delta V = -10.0 \uparrow$

$\times 14$

$\Delta M_A = 140'k$

$\Sigma H = 85^{k} \rightarrow$

$\Sigma V = 201 - 10 = 191.0^{k} \downarrow$

$\Sigma M_A = -1660 + 140 = 1520'k$

$a = \frac{1520}{191.0} = 7.96 \quad e = 16 - 7.96 = 8.04'$

(1) Resultant outside middle $\frac{1}{3}$ by $\underline{2.63}$

(2) $\frac{2}{3}\frac{\Sigma V}{7.96} = \underline{16.0}$ KSF (3) $\frac{\Sigma H}{\Sigma V} = 0.445$

(4) SSF = $\underline{1.40}$ (5) FSOT = $(\underline{4128 - 140})\frac{1}{2468} = \underline{1.62}$

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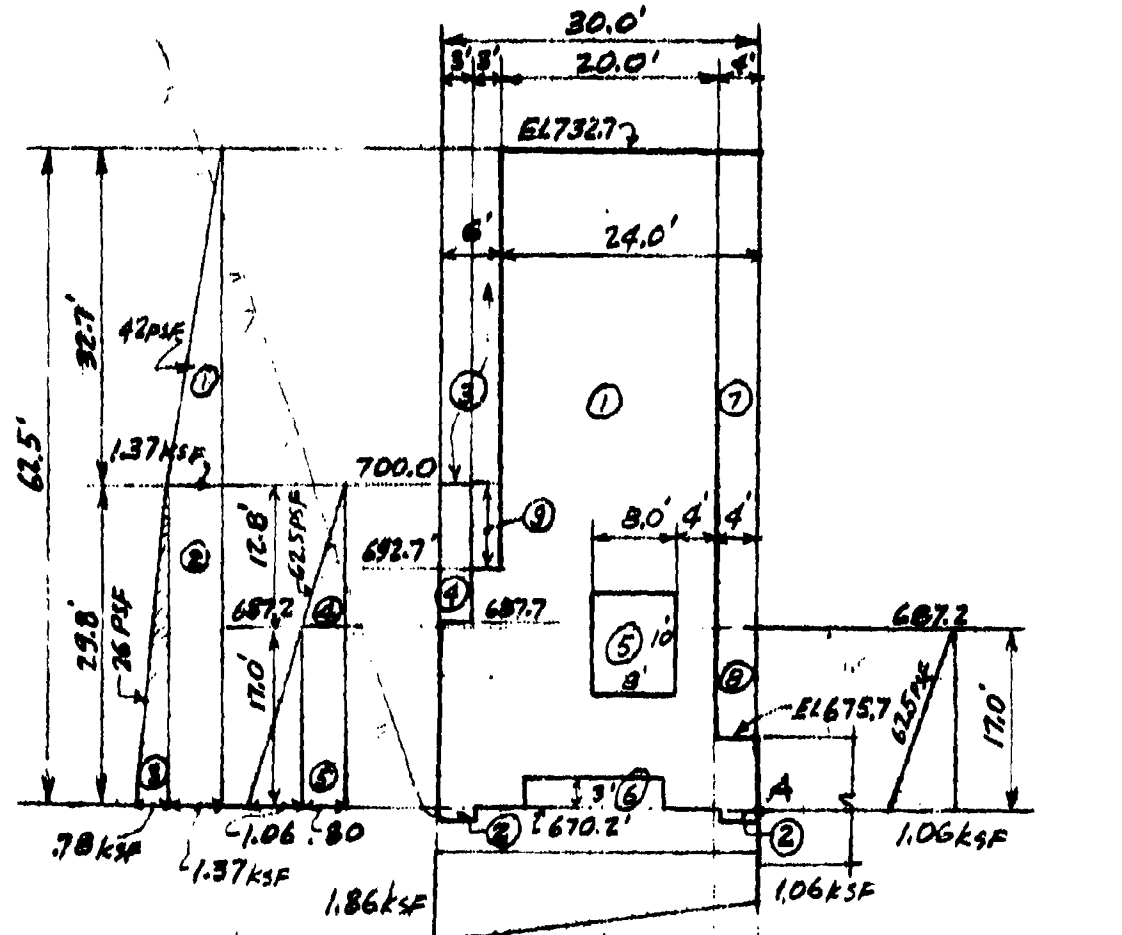
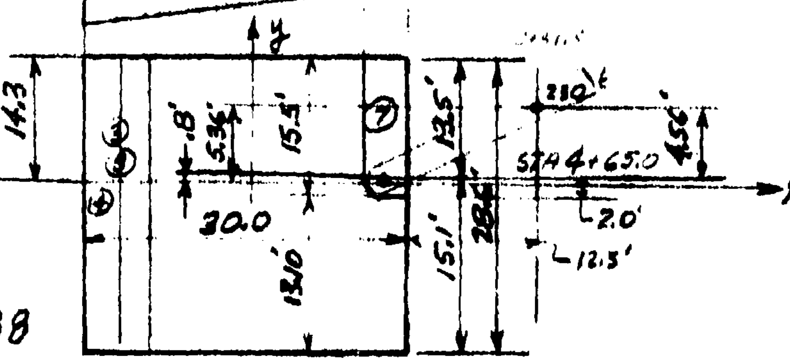
LANDWALL GATE MONOLITH #17 - EXISTING CONDITION





1. $R = 6500^k$ OUTS.

2. $\frac{\Sigma H}{\Sigma V} = \frac{2685}{5900} = .455$

3. $f_{SOIL} = 26.00\ ksf$

4. $FSS = \frac{5910 \times .625}{2685} = 1.38$

5. $FSOT = \frac{100690}{76920} = 1.41$

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LANDWALL GATE MONOLITH #17 (CONT'ED)

	LOADS IN KIPS	V ↓	V ↑	H ←	H →	ARM	$M_{A_{yy}}$ ↻	$M_{A_{yy}}$ ↺
1	30×62.5×28.6×.15	8050				15.0		120,750
2	5×2×28.6×.087	25				15.0		375
3	32.7×6×28.6×.035		196			27.0	5300	
4	5×3×28.6×.020		9			28.5	257	
5	80×28.6×.6×.088		120			12.0	1440	
	80×28.6×.4×.150		137			12.0	1650	
6	13×3×28.6×.15		168			15.0	2530	
7	45.5×15.5×4×.15		423			2.0	846	
8	11.5×15.5×4×.087		62			2.0	124	
9	7.3×6.0×28.6×.020		25			27.0	675	
	Σ	8075	1140				12,821	121,125 'k

$\Sigma V = 6935^k \downarrow$

$\Sigma M = 108,304$ 'k

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LANDWALL GATE MONOLITH #17 (CONT'D)

	LOADS IN KIPS	V ↓	V ↑	H ←	H →	ARM	M_A	M_A
W_1	30.0×28.6×1.06		912			15.0	13700	
W_2	30.0×28.6×.80×½		344			20.0	6880	
	GATE CLOSED, LOW WATER IN LOCK	230				12.5	2880	
							Σ 23460	
H_1	1.37×16.35×28.6				643	40.7	26200	
H_2	1.37×29.8×28.6				1170	14.9	17500	
H_3	.39×29.8×28.6				338	9.9	3850	53460
H_4	.40×12.8×28.6				145	21.27	3100	
H_5	.80×17.0×28.6				389	8.5	3310	
	Σ	230	1256		2685		76920	

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LANDWALL GATE MONOLITH #17 (CONT'D)

	LOAD IN KIPS	V ↓	V ↑	H ←	H →	ARM	M_{xx}
	GATE	230.0				5.36	-1230
(7)			423			6.55	+2780
		230	423				1550

SUMMARY OF LOADS

$\Sigma V = 8075 - 1140 + 230 - 1256 = 5910^k$

$\Sigma H_x = 2685^k \quad R = 6500^k$

$\Sigma M_A = 121.125 - 12821 - 76920 = 31.384^{'k}$

$\Sigma M_{xx} = 1550^{'k}$

$a_x = \dfrac{31384}{5910} = 5.30 \qquad e = 15.0 - 5.30 = 9.70$

$e_y = \dfrac{1550}{5910} = 0.26'$

$A = 28.6 \times 30.0 = 858 \text{ FT}^2$

MAXIMUM SOIL PRESSURE

$f = \dfrac{2}{3} \dfrac{5910}{28.6 \times 5.50} = 26.00 \text{ ksf}$

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LANDWALL GATE MONOLITH #17 (CONT'ED)

$\Sigma V = 5910^k \quad \Sigma H_u = 2685^k$

$\Sigma M_{yy} = 5910 \times 9.70 = 57{,}200^{\prime k}$

1. SOIL PRESSURE $f = 26.00$ KSF

2. $R = 6500.0^k$ OUTSIDE MIDDLE $\frac{1}{3}$ BY $\cancel{2.20}$ 4.10'

3. $\frac{\Sigma H}{\Sigma V} = \frac{2685}{5910} = .455$

4. $FSS = \frac{5910 \times .625}{2685} = 1.38$

5. $FSOT = \frac{108.304}{76920} = 1.41$

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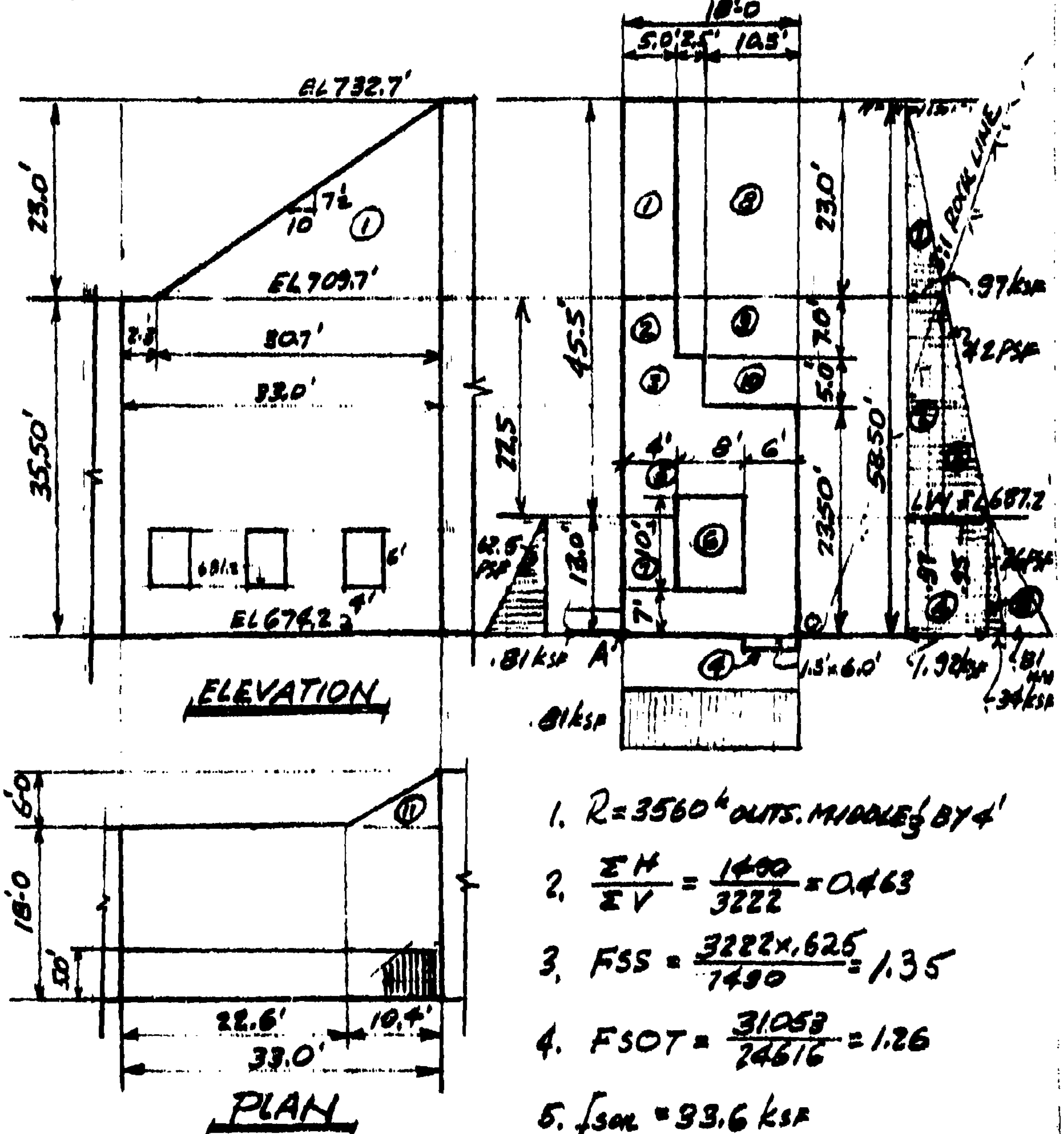
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY C LAND WALL COMPUTED M.J. CHECKED R.W.M.	PROJECT L & D #1 FILE NO. 800A DATE 11.74 PAGE 18 OF PAGES

LOWER LAND GUIDE WALL MONOLITH #1



1. $R = 3560^k$ OUTS. MIDDLE ⅓ BY 4'
2. $\frac{\Sigma H}{\Sigma V} = \frac{1490}{3222} = 0.463$
3. $FSS = \frac{3222 \times .625}{1490} = 1.35$
4. $FSOT = \frac{31053}{24616} = 1.26$
5. $f_{soil} = 33.6$ ksf

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY C LAND WALL	PROJECT LED #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO. 800A
		DATE 11.74 PAGE 19 OF ___ PAGES

LOWER LAND GUIDE WALL MONOLITH #1 (CONT'ED)

	LOADS IN KIPS	V ↓	V ↑	H ←	H →	ARM	M_A ↻	M_A ↺
C_1	23.0×30.7×2.5×.15	266				2.5	667	
C_2	7.0×5×33×.15	173				2.5	435	
C_3	7.5×5×33×.15	185				3.75	697	
C_4	9.0×33×.088	26				15.0	390	
C_5	23.5×18.0×33×.15	2090				9.0	18,800	
C_6	80.0×33×.6×.088		139			8.0		1113
	80.0×33×.4×.150		158			8.0		1263
C_7	3×96×.088		25			2.0		50
C_{11}	10.4×3×23.5×.15	110				20.0	2200	
E_8	13.0×30.7×11.5×.115	530				11.5	6100	
E_9	13×7×33×.115	345				11.5	3970	
E_{10}	10.5×5×33×.115	200				12.75	2550	
E_{11}	10.4×3×35×.115	126				20.0	2520	
W_1	.81×18×33.0		482			9.0		4350
W_{11}	.81×3×10.4		25			20.0		500
	Σ	4051	829			Σ	38,329	7276

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY GLAND WALL	PROJECT LSD #1
	COMPUTED M.T. CHECKED R.W.M.	FILE NO. 800A
		DATE 11/74 PAGE 20 OF ___ PAGES

LOWER LAND GUIDE WALL MONOLITH #1 (CNT'ED)

$H_{E1} = 4 \times .97 \times \frac{30.7}{2} \times \frac{23.0}{3} \times \frac{1}{4}$	$= 114.0$	43.17	4950 ^{1k}
$H_{E2} = .97 \times 22.5 \times 30.7 \times \frac{1}{2}$	$= 335.0$	24.25	8,120
$H_{E3} = .95 \times \frac{1}{2} \times 22.5 \times 33.0$	$= 352.0$	20.50	7,220
H_{E4} $.95 \times 13.0 \times 33.0$	$= 408.0$	6.50	2,660
H_{E4} $.97 \times 13.0 \times 33.0 \times 0.5$	$= 208.0$	6.50	1,350
$H_{E5} = .34 \times 13.0 \times 33.0 \times \frac{1}{2}$	$= 73.0$	4.33	316
	1490.0^{k}		24616^{1k}

RESULTANT $H = 1490.0^k$

$$\frac{24.616}{1490.0} = 16.50$$

$$\Sigma V = 4051 - 829 = 3222^k$$

$$\Sigma M_A = \overset{31053}{38329 - 7276} - 24616 = -6437^{1k}$$

$$\frac{6437}{3222} = 2.0'$$

1. $R = 3560^k$ OUTSIDE MIDDLE $\frac{1}{3}$

2. $\frac{\Sigma H}{\Sigma V} = \frac{1490}{3222} = 0.463$

3. $FSS = \frac{3222 \times .625}{1490.0} = 1.35$

4. $FSOT = \frac{31.053}{24616} = 1.26$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY C LAND WALL COMPUTED M.T. CHECKED	PROJECT L&D #1 FILE No. 800A DATE 11.74 PAGE 21 OF PAGES

LOWER LAND GUIDE WALL MONOLITH #1 (CONT'ED)

SOIL PRESSURE VALUE

$V = 3222^{k}$ $M_{R} = 6437^{\prime k}$ $a = 2.0^{\prime}$ $e = 7.0^{\prime}$

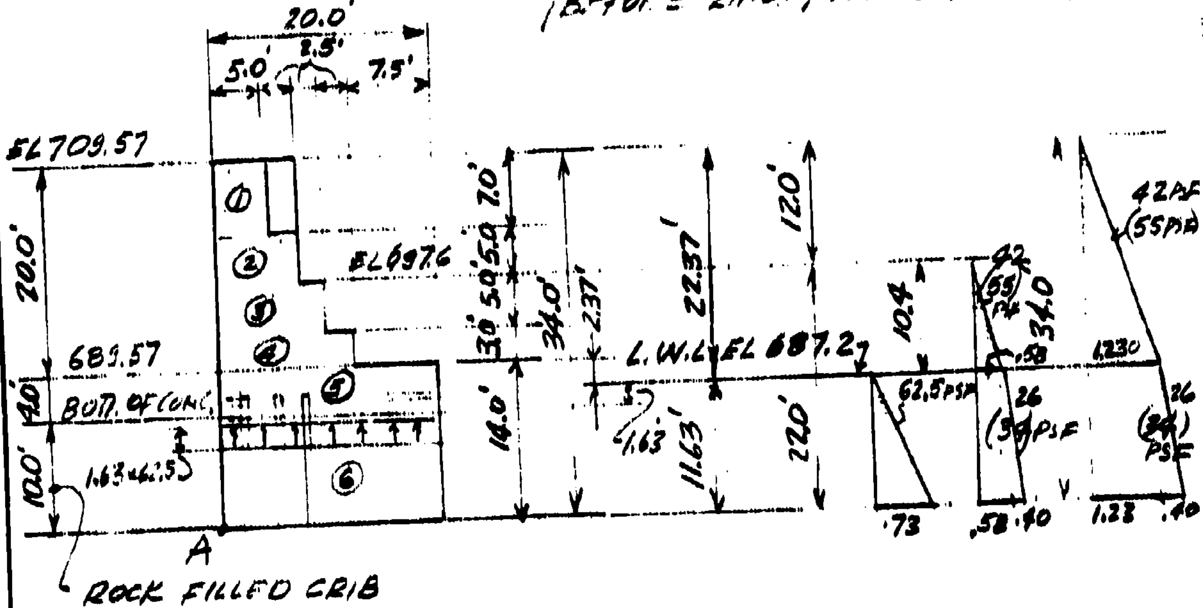
$f = \frac{2}{3} \times \frac{3222}{33 \times 2} = 33.6\ ksf$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY FOR LOWER GUIDE WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE NO. 800A DATE 8.74 PAGE 22 OF ___ PAGES

TYPICAL SECTION @ LOWER LAND GUIDE WALLS

(BEFORE BACKFILL REMOVAL)



I. CHECK STABILITY FOR BACKFILL @ TOP OF WALL

CONCRETE		BACKFILL
①	$5.0 \times 7.0 \times .15 = 5.3^k$	$15.0 \times 7.0 \times .11 = 11.6^k$
②	$7.5 \times 5.0 \times .15 = 5.6$	$12.5 \times 5.0 \times .11 = 6.9$
③	$10.0 \times 5.0 \times .15 = 7.5$	$10.0 \times 5.0 \times .11 = 5.5$
④	$12.5 \times 3.0 \times .15 = 5.6$	$7.5 \times 3.0 \times .11 = 2.5$
		26.5^k
⑤	$10.0 \times 4.0 \times .15 = 12.0$	
	36.0^k	

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LOWER GUIDE WALL BACKFILL TO TOP OF WALL	PROJECT LED #1
	COMPUTED M.J. CHECKED R.N.M.	FILE No 800A
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LOWER LAND GUIDE WALL (CONT'ED)

LOADS IN KIPS		VERT. ↓	VERT. ↑	HORIZ. →	HORIZ. ←	ARM	MOM$_A$ ↻	MOM$_A$ ↺
C_1		5.3				2.5	13.2	
C_2		5.6				3.8	21.3	
C_3		7.5				5.0	37.5	
C_4		5.6				6.25	35.0	
C_5		12.0				10.00	120.0	
E_1		11.6				12.50	146.0	
E_2		6.9				13.75	95.0	
E_3		5.5				15.00	82.5	
E_4		2.5				16.25	40.7	
W_1	1.63×.063×20		2.1			10.00		21.0
Σ		62.5	2.1				591.2	21.0
H_w	.73×11.63/2			4.3	4.3			
H_{E_1}	1.23×22.37/2				13.7	19.1		262.0
H_{E_2}	1.23×11.63				14.4	5.8		83.6
H_{E_4}	.40×11.63/2				2.3	3.9		9.0
ΣH					30.4^k			354.6$'^k$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LOWER GUIDE WALL BACKFILL TO TOP OF WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT L. & D. #1 FILE No 800A DATE 8.74 PAGE 24 OF ___ PAGES

LOWER LAND GUIDE WALL, (CONT'ED)

CHECK STABILITY INCLUDING ROCK FILLED CRIB

$10.0 \times 20.0 \times (.10 - .063) = 7.3^k$

$M_A' = 7.30 \times 10.0 = 73.0^{'k}$ $\Sigma V = 62.5 - 2.1 + 7.3 = 67.7^k$

$\Sigma M_A = 591.2 - 21.0 - 354.6 + 73.0 = 288.6^{'k}$

$a = \frac{288.6}{67.7} = 4.26'$

1. RESULTANT OUTSIDE MIDDLE $\frac{1}{2}$ BY .74'

2. $\frac{\Sigma H}{\Sigma V} = \frac{30.4}{67.7} = 0.45$ (SEE BELOW)

MAXIMUM SOIL PRESSURE

3. $f_{SOIL} = \frac{2 \times 67.70}{3 \times 4.26} = 10.6$ KSF

IF $\frac{\Sigma V \times .625}{\Sigma H} = 1.5$, $\frac{\Sigma V}{\Sigma H} = 2.73$ OR $\frac{\Sigma H}{\Sigma V} = .417$ MAX

$FS_S = \frac{67.7 \times .625}{30.4} = 1.39$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LOWER GUIDE WALL BACKFILL TO TOP OF WALL	PROJECT L.&D. #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO. 800A DATE 8.74 PAGE 25 OF PAGES

LOWER LAND GUIDE WALL (CONT'D)

CHECK STABILITY @ TOP OF CRIB

$\Sigma V = 36.0 + 26.5 - 2.1 = \underline{60.4}^k$

$\Sigma H = 1.23 \times 22.37/2 + 1.23 \times 1.63 + 1.67^2 \times .034/2$

$\Sigma H = 13.70 + 2.06 + .05 = \underline{15.81}^k$

$\Sigma M = 591.2 - 21.0 - 13.7 \times 9.1 - 2.06 \times .815 - .05 \times .54$

$\Sigma M = 591.2 - 148.0 = 443.2$

$a = \frac{443.2}{60.4} = 7.34$

1. $e = 2.66'$ WITHIN MIDDLE $\frac{1}{3}$

2. $\frac{\Sigma H}{\Sigma V} = \frac{15.81}{60.4} = .263 < .367$ OK

3. $f_{BRG} = \frac{60.4}{20.0} \pm \frac{60.4 \times 2.66}{66.7} = 3.02 \pm 2.40 \begin{cases} \text{MAX } 5.42 \text{ KSF} \\ \text{MIN } 0.62 \text{ KSF} \end{cases}$

$S = \frac{20.0^2}{6} = 66.7$

LOWER LAND GUIDE WALL (CONT'D)

CHECK STABILITY ASSUMING CRIBS FILLED IN WITH CONCRETE

CRIB WT $10 \times 20 \times (.15 - .063) = 17.4^{k}/\text{FT}$

$M_A' = 17.4 \times 10 = 174.0^{'k}$ $174 - 73 = 101^{'k}$

$\Sigma M_A = 288.6 + 101 = 389.6^{'k}$

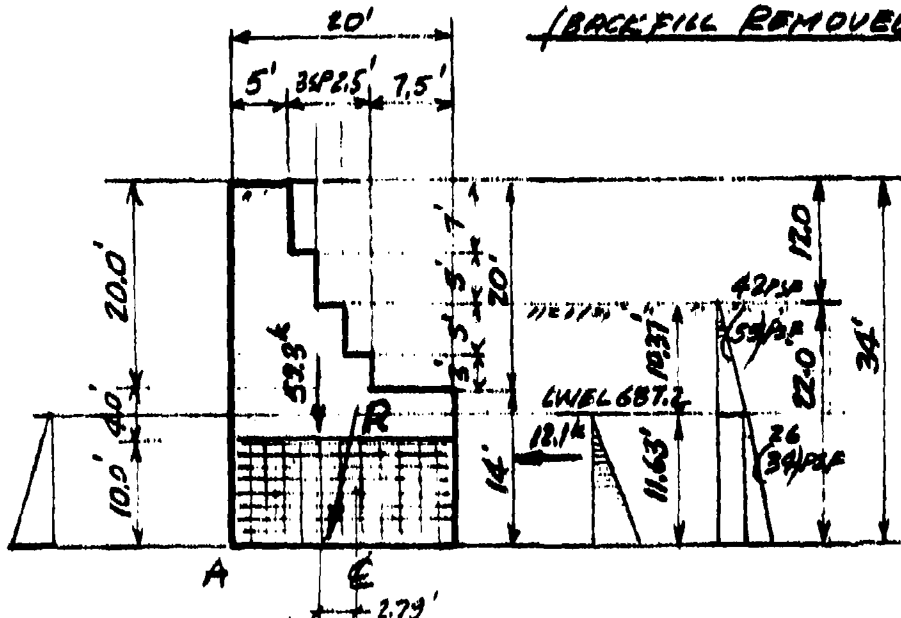
$\Sigma V = 67.7 + (17.4 - 7.3) = 77.8^{k}$

$a = \dfrac{389.6}{77.8} = 5.0'$

1. RESULTANT AT MIDDLE $\frac{1}{3}$ (BY 0.0')
2. $\dfrac{\Sigma H}{\Sigma V} = \dfrac{30.4}{77.8} = .391$ [< .417 (MAX) FOR $f_{fric} = .625$ AND F.S.S. = 1.5]
3. $f_{SOIL} = \frac{2}{3}\,\dfrac{77.8}{5.0} = 10.4$ KSF

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY COMPUTED M.J. CHECKED R.N.M.	PROJECT L & D #1 FILE No 800A DATE 10.74 PAGE 27 OF ___ PAGES

LOWER LAND GUIDE WALLS - CRIBS FILLED WITH GROUT (BACKFILL REMOVED)



$\underline{K = 0.50}$ (SOIL PRESSURE AT REST CONDITION)

$\Sigma V = 59.3^k$

$\Sigma H = 12.1^k$

$\Sigma M_A = 409.4'^k$ $\quad a = \frac{409.4}{59.3} = 6.9'$ $\quad e = 3.10' < \frac{20.0}{6} = 3.33$

R = 61.2^k INSIDE MIDDLE $\frac{1}{3}$

$\frac{\Sigma H}{\Sigma V} = 0.205 < .417$ / ff = .625 FSS = 1.5

$FSS = \frac{59.3 \times .625}{12.1} = 3.06$

f_{soil} = MAX 5.73 ksf, MIN .21 ksf

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LOWER GUIDE WALL BACKFILL REMOVED TO EL 697.6 COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE No. 800A DATE 8.74 PAGE 28 OF ___ PAGES

LOWER LAND GUIDE WALL WITH BACKFILL REMOVED TO EL 697.6
(CONCRETE FILLED CRIB)

	LOADS IN KIPS	VERT. ↓	VERT. ↑	HORIZ. →	HORIZ. ←	ARM	M_A ↻	M_A ↺
C_1		5.3					13.2	
C_2		5.6					21.3	
C_3		7.5					37.5	
C_4		5.6					35.0	
C_5		12.0					120.0	
C_6	10.0×20.0×.087	17.4				10.	174.0	
E_3		5.5					82.5	
E_4		2.5					40.7	
W_1			2.1			10.		21.0
Σ		61.4	2.1				524.2	21.0
H_{E_3}	10.4×.58/2				3.0	15.1		45.3
H_{E_4}	11.63×.58				6.8	5.8		39.5
H_{E_5}	11.63×.20				2.3	3.9		9.0
Σ		61.4	2.1		12.1		524.2	114.8

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LOWER GUIDE WALL BACKFILL REMOVED TO EL 697.6	PROJECT L.&D #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO. 800A
		DATE 8.74 PAGE 29 OF PAGES

LOWER LAND GUIDE WALL WITH BACKFILL REMOVED (CONT'D)

$\Sigma V = 61.4 - 2.1 = 59.3^{k}$

$\Sigma H = 12.1^{k}$

$\Sigma M_A = 524.2 - 114.8 = 409.4^{\prime k}$

$a = \frac{409.4}{59.3} = 6.9$

1). $e = 10.0 - 6.9 = 3.1$ RESULTANT WITHIN MIDDLE $\frac{1}{3}$

$M = 59.3 \times 3.1 = 183.8^{\prime k}$

2). $\frac{\Sigma H}{\Sigma V} = \frac{12.1}{59.3} = 0.205$

3). $f_{soil} = \frac{59.3}{20.0} \pm \frac{183.8}{66.7} = 2.97 \pm 2.76 \begin{cases} \text{MAX} & 5.73 \text{ ksf} \\ \text{MIN} & 0.21 \text{ ksf} \end{cases}$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITION OF STABILITY COMPUTED M.T. CHECKED R.N.M.	PROJECT L&D #1 FILE NO. 800A DATE 11.74 PAGE 30 OF ___ PAGES

LOWER LAND GUIDE WALLS - BACKFILL REMOVED (CON'T'D)

(SOIL PRESS. 42PSF & 26PSF)

			M_A
$H_{E1} = .042 \times 10.37^2/2 = 2.25^k$		$\times$ 15.10	$34.00^{\prime k}$
$H_{E2} = .435 \times 11.63 = 5.07^k$		$\times$ 5.80	29.40
$H_{E3} = .304 \times 11.63/2 = 1.77^k$		$\times$ 3.90	6.92
$\Sigma H = 9.09^k$			$70.32^{\prime k}$

$\Sigma M_A = 524.2 - 21.0 - 70.3 = 432.9^{\prime k}$

$\Sigma V = 61.4 - 2.1 = 59.3^k$

$\Sigma H = 9.1^k$

$a = \frac{432.9}{59.3} = 7.3'$

$e = 2.7' < 3.33'$ (USED)

1). $R = 59.3^k$ INSIDE MIDDLE $\frac{1}{3}$ BY 0.63'

2). $\frac{\Sigma H}{\Sigma V} = \frac{9.10}{59.3} = .154$

3). $f_{SOIL} = \frac{59.3}{20.0} \pm \frac{59.3 \times 2.7}{66.70}$ $S = \frac{20.0^2}{6} = 66.70\ FT^3$

$f_{SOIL} = 2.97 \pm 2.42$

$f_{MAX} = 5.39\ KSF$ $f_{MIN} = .55\ KSF$

4). $FSS = \frac{59.3 \times .625}{9.10} = 4.07$

5). $FSOT = 5.75$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITION OF STABILITY	PROJECT L & D #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO. 800 A
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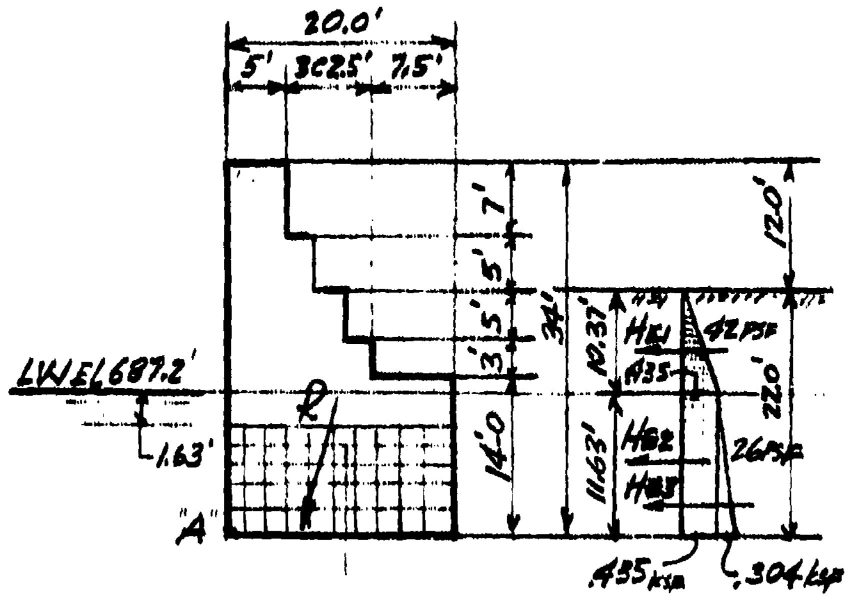
LOWER LAND GUIDE WALLS - BACKFILL REMOVED



1). $R = 59.3^k$ INSIDE MIDDLE $\frac{1}{3}$ BY 0.63

2). $\frac{\Sigma H}{\Sigma V} = \frac{9.10}{59.3} = .153$

3). $f_{SOIL} = $ MAX 5.39 ksf / MIN 0.55 ksf

4). $FSS = \frac{59.3 \times .625}{9.10} = 4.07$

5). $FSOT = 5.75$

16.6 STABILITY OF LOWER GUIDE WALL MONOLITHS 6-12 DURING CONSTRUCTION PERIOD (Backfill removed) Ref. page 27

According to water level readings in borehole No. 74-8U and downstream of the lock chamber the difference in hydraulic grade line was about 7' on Sept. 10, 1974. Using the same difference, assume that the hydraulic grade line behind the lower guide wall monoliths is approximately, 674+7 = 681' when the construction area is dewatered.

Assume 3' of surcharge

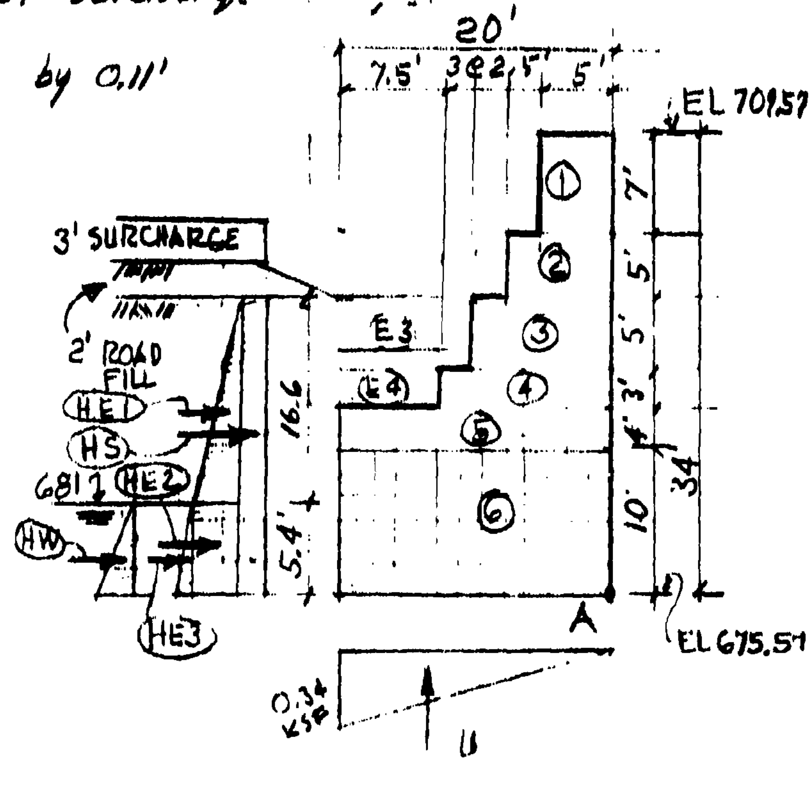
(1) "R" inside middle $\frac{1}{3}$ by 0.11'

(2) $\frac{\Sigma H}{\Sigma V} = 0.22$

(3) FSS = 2.84

(4) f_{soil} = 6.95 KSF max
0.12 KSF min

(5) FSOT = 3.78



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LOWER GUIDE WALL STABILITY, CONSTRUCTION CONDITION	PROJECT LOCK & DAM #1
	COMPUTED R.N.M. CHECKED JI	FILE NO. 800 A
		DATE 2/'75 PAGE 31 b OF ___ PAGES

CONSTRUCTION CONDITION

		H →(+)	V (+)↓	ARM	(+) MA	(−) MA
①-⑤	See page 28		+36.0			227
E3			+5.5	15.0		83
E4			+2.5	16.25		41
⑥	10 × 20 × 0.15		30.0	10		300
U	$0.0625 \times 5.4 \times 20 \times \frac{1}{2}$		−3.4	13.3	45	
HS	$5 \times 0.042 \times 22$	+4.6		11.0	51	
HE1	$0.042 \times (16.6)^2 \times \frac{1}{2}$	+5.8		10.9	63	
HE2	$0.042(16.6) \times 5.4$	+3.8		2.7	10	
HE3	$0.026(5.4)^2 \times \frac{1}{2}$	+0.4		1.8	1	
HW	$0.0625(5.4)^2 \times \frac{1}{2}$	+0.9		1.8	2	
		$\Sigma H = 15.5^K$	$\Sigma V = 70.6^K$		172'k	651'k
					$\Sigma M_A = 479$'k	

1) $\bar{X} = \frac{479}{70.6} = 6.78'$ $e = 3.22'$

Resultant inside middle $\frac{1}{3}$, 0.11 ft

2) $\frac{\Sigma H}{\Sigma V} = \frac{15.5}{70.6} = 0.22$ (3) FSS = 2.84

4) $f_{soil} = \frac{70.6}{20}\left(1 \pm \frac{6 \times 3.22}{20}\right)$ = 6.95 KSF max. − 0.12 KSF min.

5) $FSOT = \frac{651}{172} = 3.78$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY CONDITIONS AT INTERMEDIATE WALL	PROJECT LED #1
	COMPUTED M.J. CHECKED RNM.	FILE No. 800A
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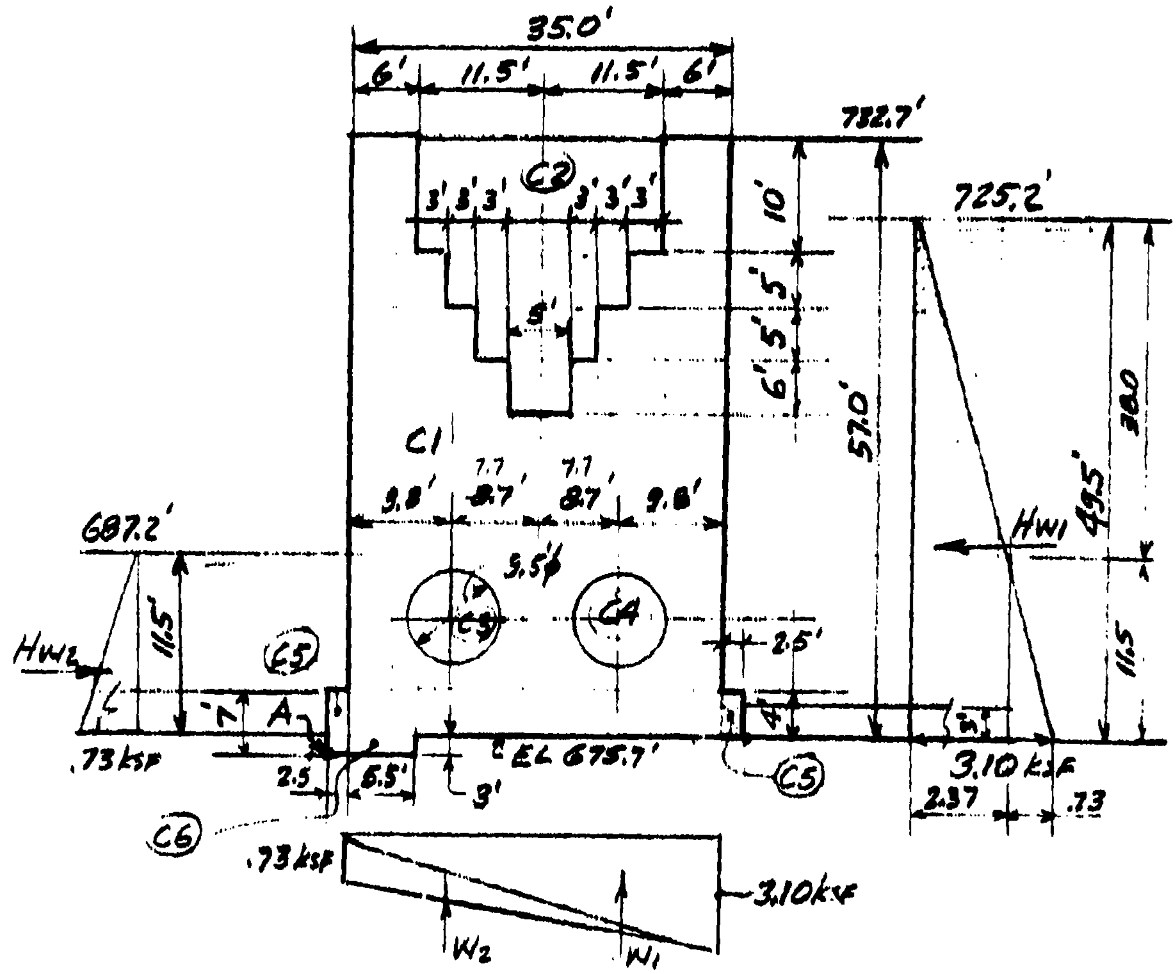
INTERMEDIATE WALL MONOLITHS #4-16



NORMAL OPERATING CONDITION

1). RESULTANT OUTS. $\frac{1}{3}$ BY 0.59

2). $\frac{\Sigma H}{\Sigma V} = \frac{2031}{5844} = .348$

3). f_{SOIL} = 10.90 KSF

4). FSS = 1.80

5). FSOT = 1.94

CONSTRUCTION CONDITION (ONE LOCK EMPTY)

1). RESULTANT OUTS. $\frac{1}{3}$ BY. 0.56

2). $\frac{\Sigma H}{\Sigma V}$ = .354

3). f_{SOIL} = 11.32 KSF

4). FSS = 1.77

5). FSOT = 2.02

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY CONDITIONS AT INTERMEDIATE WALL	PROJECT LED #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO 800A
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INTERMEDIATE WALL MONOLITHS #4-16

		$V\downarrow_k$	$V\uparrow_k$	$H\rightarrow_k$	$H\leftarrow_k$	ARM	$M_{℄}$ ↻	$M_{℄}$ ↺
C1	35.0×57.0×28×.15	8380				0.		
C2	(10×23+170)×28×.035 5×17+5×11+6×5 = 1		392			0.		
C3	π×4.8²×28×.088		178			0.		
C4	π×4.8²×28×.088		178			0.		
C5	2×2.5×4.0×28×.088	49				0.		
C6	5.5×3.0×28×.088	41				16.0		660
	Σ	8470	748					
HW1	3.10×24.75×28				2148	16.5		35,500
HW2	.73×11.5/2×28			117		3.84	450	
W1	3.10×17.5×28		1520			5.83		8860
W2	.73×17.5×28		358			5.83	2090	
				117 →	2148 ←	Σ	2540	45,020

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY CONDITIONS AT INTERMEDIATE WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT L & D #1 FILE NO. 800A DATE 11.74 PAGE 34 OF ___ PAGES

INTERMEDIATE WALL MONOLITHS #4-16 (CONT'D)

NORMAL OPERATING CONDITION (W.L @ 725.2' & 687.2')

$\Sigma V = 8470 - 748 - 1520 - 358 = 5844^k$

$\Sigma H = 2148 - 117 = 2031^k$

$\Sigma M_{\mathbb{C}} = 45020 - 2540 = 42480'^k$

$e = \frac{42480}{5844} = 7.26'$ $\frac{40.0}{6} = 6.67'$ $a = 12.74'$

1). RESULTANT OUTSIDE MIDDLE $\frac{1}{3}$ BY 0.59'

2). $\frac{\Sigma H}{\Sigma V} = \frac{2031}{5844} = .348$

3). $f_{SOIL} = \frac{2}{3} \times \frac{5844}{28 \times 12.74} = 10.90$ ksf

4). $FSS = \frac{5884 \times .625}{2031} = 1.80$

5). $FSOT = \frac{7722 \times 20}{79550} = 1.94$ $8470 - 748 = 7722^k$

$M_A = 35500 + .73 \times 35.0 \times 28.0 \times 20 + \frac{2.37}{2} \times 35.0 \times 28 \times 25.84$

$-450 = 35500 + 14300 + 30200 - 450 = 79550$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY CONDITIONS AT INTERMEDIATE WALL	PROJECT LED #1
	COMPUTED M.J. CHECKED R.N.M.	FILE No. 800A
		DATE 11.74 PAGE 35 OF PAGES

INTERMEDIATE WALL MONOLITHS #4-16

REHABILITATION CONDITION - ONE LOCK EMPTY (CONSTRUCTION)

$\Sigma V = 8470 - 748 - 1520 - 126 = 6076^k$ (2268)

$\Sigma H = 2148^k$ $\quad C_3 = \pi \times 4.8^2 \times 28 \times .15 = 304^k$ $\quad \begin{array}{r} 304 \\ \underline{178} \\ 126^k \end{array}$

$\Sigma M_{\mathfrak{L}} = 45{,}020 - 126 \times 8.7 = 43{,}920'^k$

$e = \frac{43920}{6076} = 7.23'$

$a = 12.77$

1). RESULTANT OUTSIDE MIDDLE $\frac{1}{3}$ BY $.56'$

2). $\frac{\Sigma H}{\Sigma V} = \frac{2148}{6076} = .354$

3). $f_{soil} = \frac{2}{3} \times \frac{6076}{28 \times 12.77} = 11.32$ ksf

4). $FSS = \frac{6076 \times .625}{2148} = 1.77$

5). $FSOT = \frac{7722 \times 20}{76450} = 2.02$

$M_A = 35{,}500 + \frac{3.10}{2} \times 350 \times 28.0 \times 25.84 + 126 \times 12.3 =$

$= 35{,}500 + 39{,}400 + 1550 = 76450'^k$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL STABILITY - TEMPORARY CONSTRUCTION	PROJECT LOCK & DAM # 1
	COMPUTED R.N.M. CHECKED JI	FILE NO. 800 A
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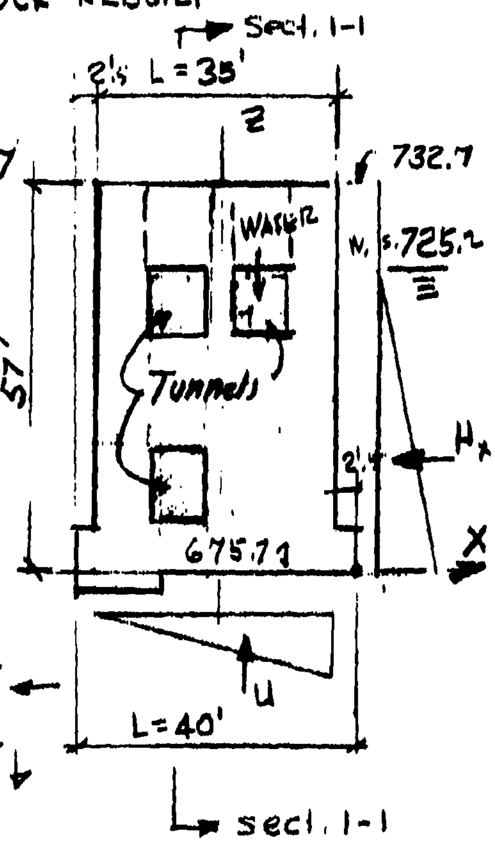
REHABILITATION PLAN 2 — MONOLITH NO. 4
INTERMEDIATE WALL, LANDWARD LOCK REBUILT
RIVERLOCK — NO CHANGE



1) Resultant inside middle 1/3 by .57
2) Factor of sliding = .39
3) Sliding safety factor = 1.61
4) Bearing pressure = 9.66 KSF
5) F.S.O.T. = 1.89

ΣH_x = ... 1858^k

ΣV = ... 4789^k

ΣM_x .... $+923'k$

ΣM_Y .... $-29343'k$

$$\frac{\Sigma H_x}{\Sigma V} = \frac{1858}{4789} = .39 \qquad SSF = 1.61$$

$$\left.\begin{aligned} e_x &= \frac{\Sigma M_y}{\Sigma V} = \frac{29343}{4789} = 6.1 \qquad \frac{e_x}{40} = 0.15 \\ e_y &= \frac{\Sigma M_x}{\Sigma V} = \frac{923}{4789} = .2 \qquad \frac{e_y}{24.3} = 0.01 \end{aligned}\right\} K = 1.96$$

$$f_s = \frac{1.96 \times 4789}{972} = 9.66 \text{ KSF}$$

8862 - 816 + 936 = 8982
7272 - 1386 + 51 + 43 + 122 = 6102

$$F.S.O.T. = \frac{6102\,(17.5 + 1.47)}{1343 \times 23.33 + 30657} = 1.89 \qquad \frac{8982}{6102} = 1.47$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL STABILITY-TEMPORARY CONSTRUCTION	PROJECT LOCK & DAM #1
	COMPUTED R.N.M. CHECKED JJ	FILE NO 8001
		DATE 2/'75 PAGE 35b OF ___ PAGES

REHABILITATION PLAN 2 – MONOLITH No 4 (CONT'D)

		V	Y	X	M_X	M_Y
①	14 x 14 x 24 (-0.15)	-706	2.95	-7.67	+2083	+5415
	$\frac{1}{2}$ x 8.0 x 7.0 x 9 (.15)	+38	+6.5	-7.67	-247	-291
②	3 x 10 x 24 (-0.15)	-108	-8.0	-7.67	-864	+828
③	$\frac{15.5+21}{2}$ (7.8)(9)(-0.15)	-192	+8.5	-7.67	+1632	+1473
④	$\frac{21+17}{2}$ (4.35)(9)(-0.15)	-110	+2.2	-7.67	+242	+844
⑤	$\frac{17+12}{2}$ (7.2)(-0.15)(9)	-141	-3.6	-7.67	-508	+1081
⑥	$\frac{12+11}{2}$ (5)(9)(-0.15)	-78	-9.65	-7.67	-753	+598
⑦	24.3 x 11 x 9 (-0.15)	-361	0	+7.67	0.	-2769
	3.5 x 11 x 9 (-0.15)	-52	+10.5	-7.67	+546	+399
	2.0 x 11 x 9 (-0.15)	-30	-6.1	-7.67	-183	+230
	3.5 x 3.0 x $\frac{1}{2}$ x 9 (-.15)	-7	+9.8	-7.67	+67	+54
		V_1 = 1386^k			M = +923'k	+8062'k
GROSS CONC.	57 x 24.3 x 35 x 0.15 =	+7272	0	0	0	0
	3 x 8 x 24.3 x .088 =	+51	0	16	0	-816
	4 x 5 x 24.3 x .088 =	+43	0	0	0	0
	Water: 8 x 10 x 24.3 x .0625	+122	0	7.67	0	+936
	U = 49.5 x .0624 x 35 x 24.3 x $\frac{1}{2}$ =	-1313	0	5.84	0	-7668
	ΣH_x = $\frac{49.5^2}{2}$ x .0624 x 24.3 = 1858^k					-30651
	ΣV =	4789^k			ΣM_X = +923'k	

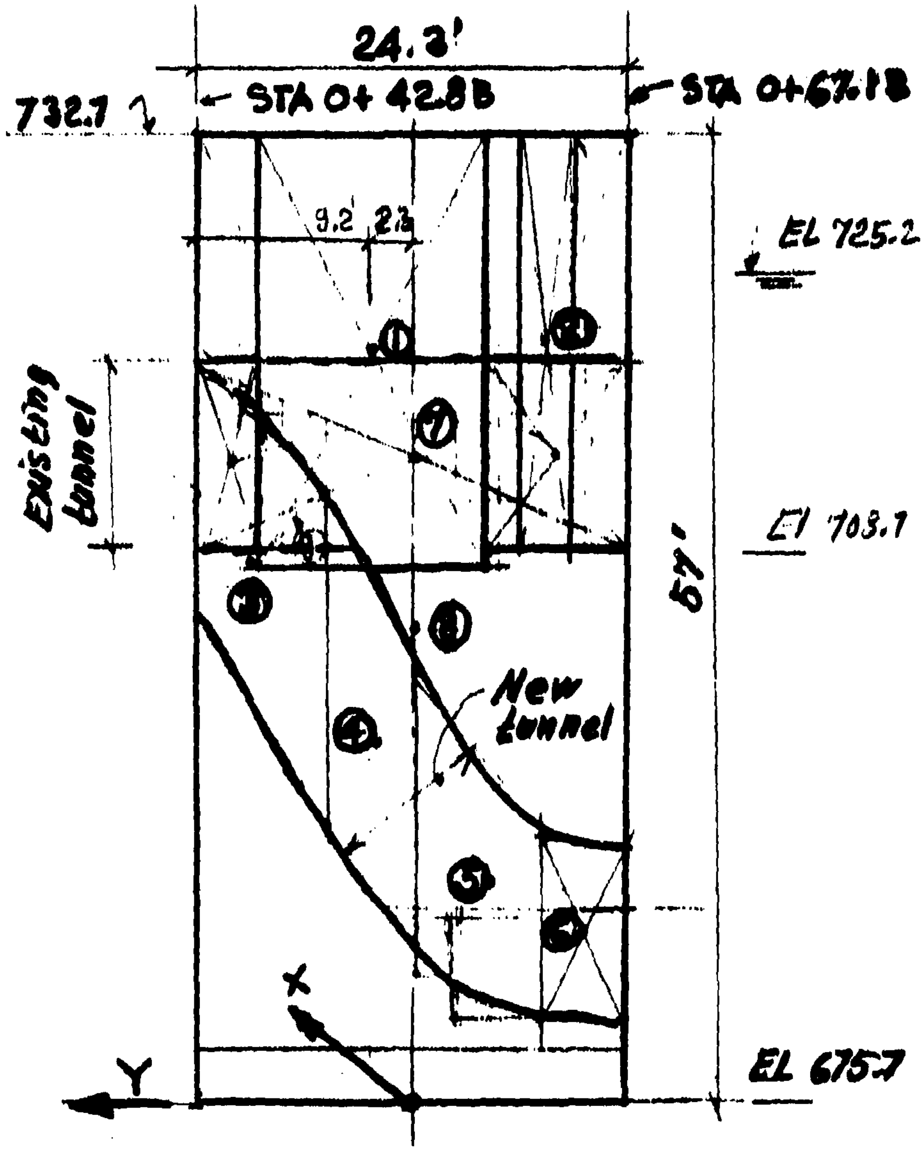
ΣM_Y = -29343'k

Calc. openings

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL STABILITY - TEMPORARY CONSTRUCTION	PROJECT LOCK & DAM #1
	COMPUTED R.H.M. CHECKED	FILE No 800 A
		DATE 2/'75 PAGE 35C OF PAGES

REHABILITATION PLAN 2 - MONOLITH #4 (CONT'D)



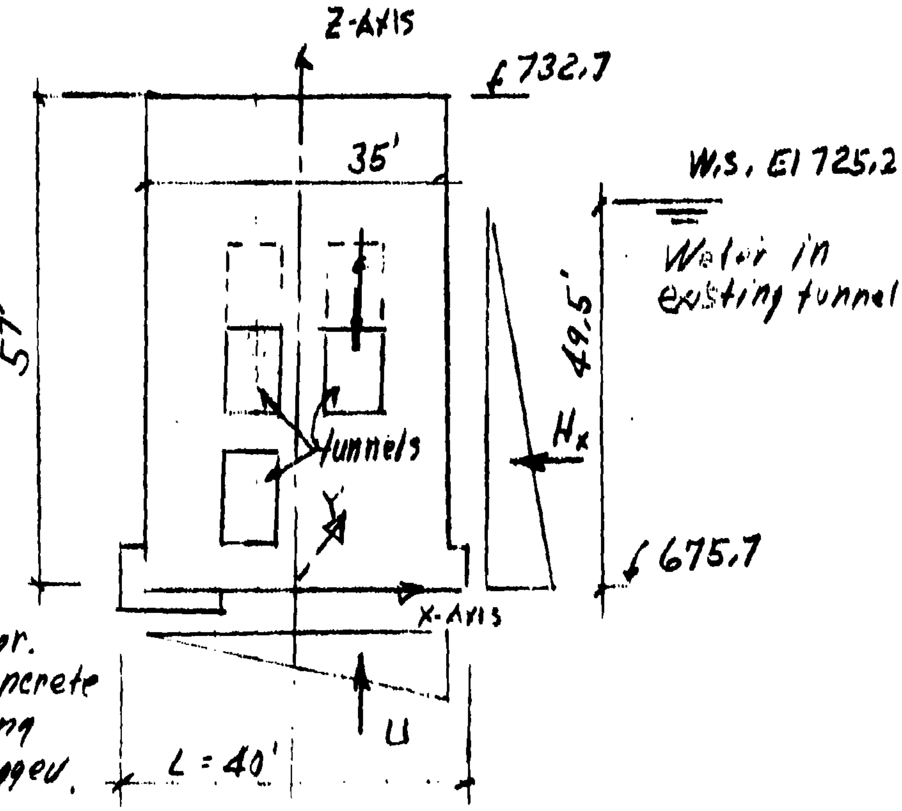
Sect. 1-1

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL STABILITY - TEMPORARY CONSTRUCTION COMPUTED R.N.M. CHECKED [illegible]	PROJECT LOCK & DAM NO. 1 FILE No 800 A DATE 2/'75 PAGE 35d OF ___ PAGES

REHABILITATION PLAN 2 - MONOLITH NO. 5

INTERMEDIATE WALL LANDWARD LOCK CULVERT REBUILT *

NO CHANGE IN RIVERLOCK



* New vertical & hor. opening cut, concrete removed, existing opening not plugged.

1) Resultant outside middle 1/3 by 0.9'
2) Factor of sliding = .41
3) Factor of safety against sliding = 1.54
4) Bearing pressure = 11.30 KSF
5) F.S.O.T. = 1.90

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL STABILITY-TEMPORARY CONSTRUCTION COMPUTED R. N. M. CHECKED JI	PROJECT LOCK & DAM #1 FILE No. 800 A DATE 2/'75 PAGE 35 e OF ___ PAGES

REHABILITATION PLAN 2 - MONOLITH #5 (CONT'D)

CONCRETE		ARM Y	ARM X	MOMENT M_X	MOMENT M_Y
① 7×13.5×9×(−0.15)	= −128	+6.5	−7.67	+832	981
② $\frac{15+13}{2}$×4.8×8(−0.15)×2	= −161	−12.5	0.0	−2013	0
③ $\frac{13+12}{2}$×5.1×8(−0.15)×2	= −153	−7.5	0.0	−1148	0
④ $\frac{12+11.5}{2}$×5×8(−0.15)×2	= −141	−2.5	0.0	−353	0
⑤ 10×15.1×8 (−0.15) ×2	= −362	+7.5	0.0	+2715	0
⑥ 10×7×(9−8)(−0.15)	= −11	+6.0	−7.67	+66	+84
⑦ 8×12.5×9(−0.15)	= −135	+6.5	−7.67	+878	+1035
⑧ 5.5×5×9 (−0.15)	= −37	+6.5	−7.67	+241	+284
⑨ 30×9×11 (−0.15)	= −446	0	−7.67	0	+3419
⑩ 10^2 (−0.15)×13	= ~~−150~~ −195	+8.0	+7.67	+1560	−1495
⑪ 3×9×13(−0.15)	= −53	−1.5	+7.67	−80	−406
	−1822				
35×57×30×0.15	= +8978	0	0	0	0
3×3×30×0.088	= +64	0	−16.0	0	−1024
4×5×30×0.088	= +53	0	0	0	0
	V_1 = +7273 k		M_{X_1} =	2698	
			ΣM_{Y_1} =		+2878

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL STABILITY - TEMPORARY CONSTRUCTION	PROJECT LOCK & DAM #1
	COMPUTED R.N.M. CHECKED JJ	FILE No. 800 A
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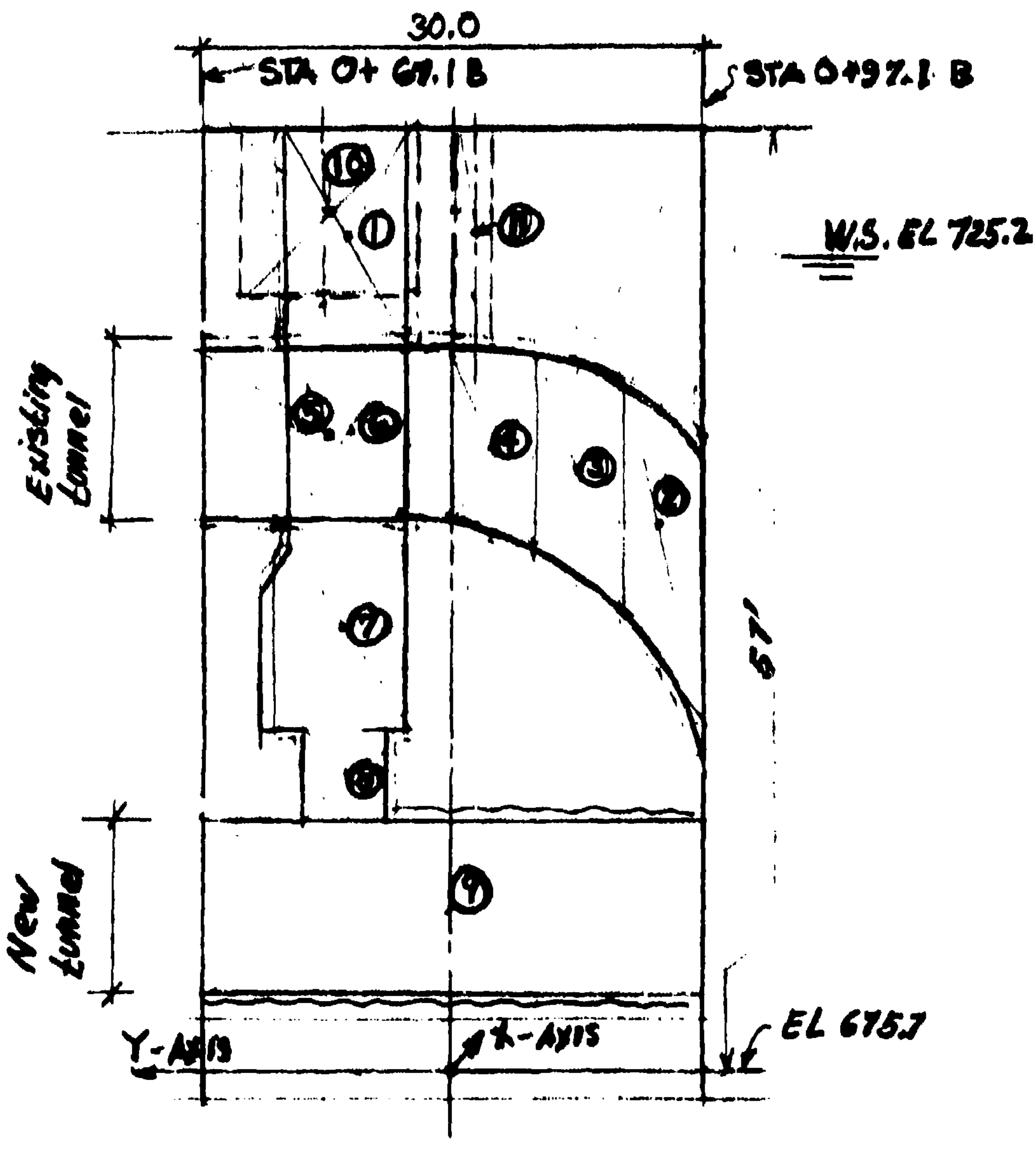
REHABILITATION PLAN 2 - MONOLITH # 5 (CONT'D)



REHABILITATION PLAN 2 - MONOLITH NO. 5 (CONT'D)

		H	V	Y	X	M_x	M_Y
			~~+7318~~ +7273	.4	~~0.28~~ .37	+2698	+2878
Water in riverward tunnel							
(2)'	80 x 0.0625/0.15		+33	-12.5	+7.67	+413	+253
(3)'	77 x 0.0625/0.15		+32	-7.5	+7.67	+240	+245
(4)'	70 x 0.0625/0.15		+29	-2.5	+7.67	+ 73	+222
(5)'	181 x 0.0625/0.15		+75	+7.5	+7.67	-563	+575
			+169		1..	+163	1295
H_Y	$\frac{49.5^2}{2}$ x .0624 x 30	-2293		z = 16.5		—	-37835
U	49.5 x .0624 x 35 x 30		-1622		+5.84	—	-9472

$\Sigma H = -2293^k$ $\qquad \Sigma M_x = +2861^k$

$\Sigma V = 5651^k$ $\qquad \Sigma M_y = -43134^k$

$e_x = \frac{43134}{5651} = 7.6 \qquad \frac{e_x}{40} = 0.19$

$e_y = \frac{2861}{5651} = .51 \qquad \frac{e_y}{30} = 0.02$ $\quad k = 2.4$

$e > \frac{L}{6}$ by 0.9

$f = \frac{2.4 \times 5651}{1200} = 11.30$ KSF

$\frac{\Sigma H}{\Sigma V} = \frac{2293}{5651} = .406 \qquad SSF = 1.54$

$F.O.T. = \frac{7273 \times 20.37 + 169 \times 21}{37835 + 1622 \times 25.84} = \frac{151700}{79147} = 1.90$

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONO. #18	PROJECT L.&D. #1
	COMPUTED M.J. CHECKED R.N.M	FILE NO. 800A
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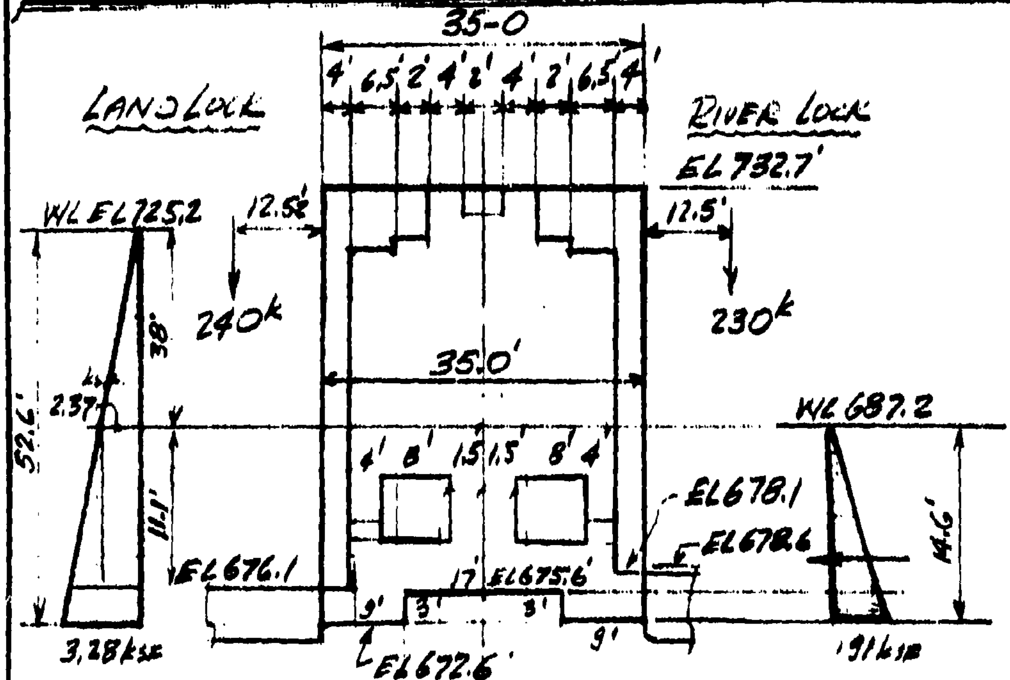
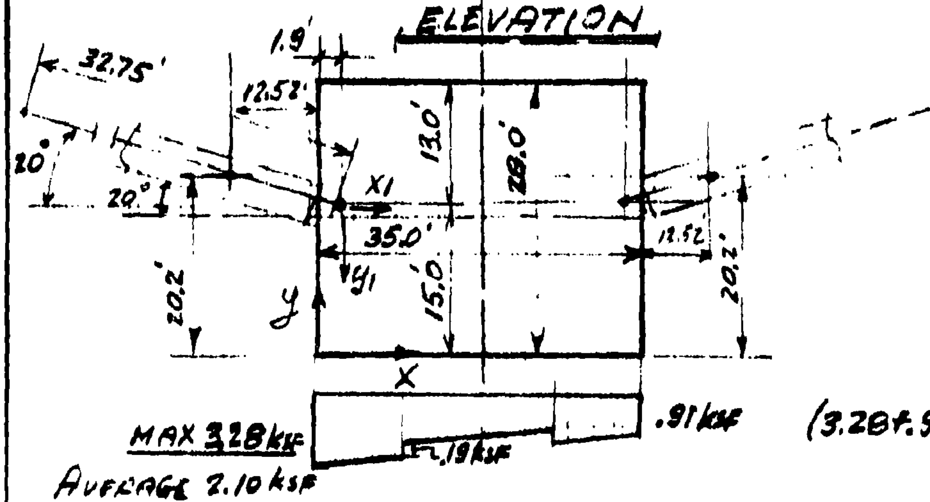
INTERMEDIATE WALL GATE MONOLITH #18 - EXISTING CONDITIONS





$(3.28+.91)\frac{1}{2} = 2.10$ ksf

$\Sigma V = 6081^k$ $\Sigma M_{xx} = 37.606'^k$ $\Sigma M_{yy} = 181.105'^k$ $\Sigma H = 3650^k$

1). $e_x = 12.4'$; $e_y = 7.9'$

2). $f_{soil} = 74.5$ KSF

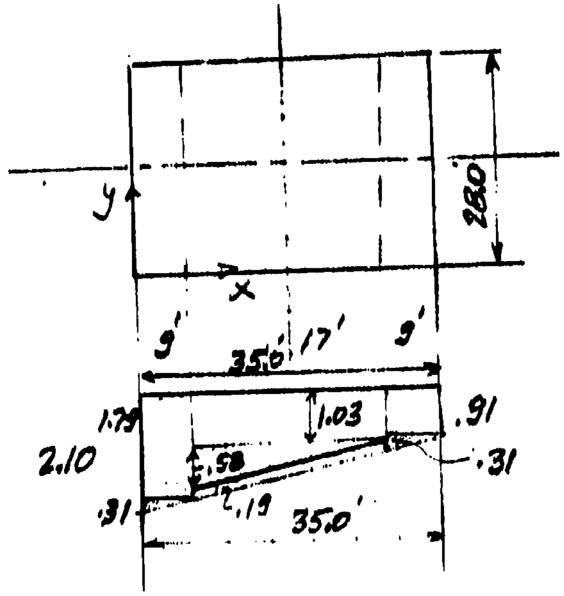
3). $\frac{\Sigma H}{\Sigma V} = \frac{3650}{6081} = 0.60$

4). $FSS = \frac{6081 \cdot .625}{3650} = 1.04$

5) FSOT = 1.03

INTERMEDIATE WALL MONOLITH #18 (CONT'ED)

HYDROSTATIC LOAD



2.10
.91
1.19 / 35.0 = 0.0341

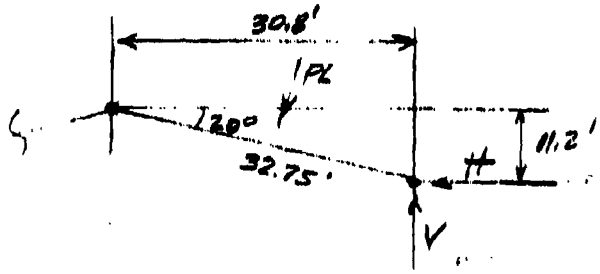
.15 × 9.0	=	1.35	× 6.0	8.12
.910 × 9.0	=	8.20	× 4.5	37.00
1.03 × 17.0	=	17.50	× 17.5	307.00
1.79 × 9.0	=	16.10	× 30.5	492.00
.15 × 9.0	=	1.35	× 32.0	43.30
.29 × 17.0	=	4.92	× 20.3	100.00
		49.42^k		987.42

49.42 × 28.0 = 1380.0^k

$\frac{987.4}{49.42} = 20.0'$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONO. #18 COMPUTED M. J. CHECKED RNM	PROJECT LED #1 FILE No. 300 A DATE 9.74 PAGE 38 OF ___ PAGES

INTERMEDIATE WALL MONOLITH #18 (CONT'D)



$\sin 20 = .342$

$\cos 20 = .940$

$$PL = \left(2.37 \times \overset{45.2}{38.0/2} + \overset{71.6}{} 2.37 \times \overset{26.4}{11.1}\right) 32.75 = 2350^k$$

$$V = 2350 \times .940 = \underline{2210}^k = Y1$$

$$2350 \times 16.37 + 11.2\,H = 2210 \times 30.8$$

$$38500 - 68200 = -11.2\,H$$

$$H = X1 = \underline{2650}^k$$

45.2 ×	23.7	=	1070.0
26.4 ×	5.5	=	145.0
71.6			1215.0 ′k

$$a = \frac{1215.0}{71.60} = 17.0 \text{ (ABOVE EL 676.10)}$$

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONO. #18	PROJECT L & D #1
	COMPUTED M. J. CHECKED RNM	FILE NO 800 A
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INTERMEDIATE WALL DOWNSTREAM GATE MONO. #18

	VERT ↓ K.	VERT ↑ K.	HORIZ. →	HORIZ. ←	ARM	±Mxx	Myy
MONOLITH	6.634					+87.100	116.980
GATES L.L.	240					+ 4920	-3,360
R.L.	230					+ 4.635	10.925
WATER IN LANDWARD CULVERT	357					+ 5.651	2,560
HYDROSTATIC L. ↑	-1380				14.00 15.00	-19.400	-20,800
GATE THRUST X1 →			2650				54,300
" " Y1 ↓			↓ 2210		20.5	-45,300	
HYDROSTATIC →			1,000				20,500
	6081					37,606	181,105

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONO. #18 COMPUTED M.J. CHECKED RNM	PROJECT L & D #1 FILE NO. 800A DATE 9.74 PAGE 40 OF ___ PAGES

INTERMEDIATE WALL MONOLITH #18 (CONT'D)

HYDROSTATIC LOAD ON LAND LOCK SIDE

$$2.37 \times \overset{45.2}{38.0/2} + \overset{26.4}{2.37 \times 11.1} = 71.6$$

$$71.6 \times 14.0 = 1000^{k} \text{ @ } 17.0' \text{ ABOVE SILL EL } 676.1$$

$$M_{yy} = 1000 \times (\overset{20.5}{17.0 + (\overset{3.5}{676.1 - 672.6})}) = 20500'^{k}$$

SOIL PRESSURE AND LOCATION OF RESULTANT

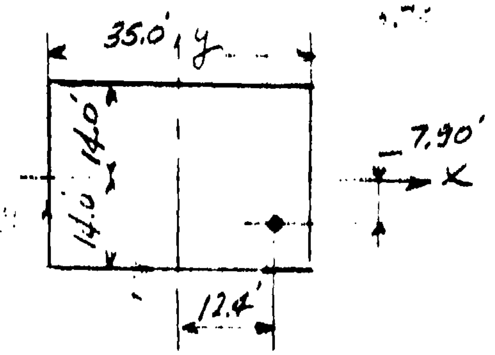
$$\Sigma V = 6031^{k}$$

$\Sigma M_{xx} = 37606'^{k}$ $\quad a_{yy} = 6.10'$

$\Sigma M_{yy} = 181105'^{k}$ $\quad a_{xx} = 29.90'$

$e_{yy} = 14.0 - 6.10 = 7.90'$ OUTSIDE MIDDLE ⅓ BY 0.90'

$e_{xx} = 29.9 - 17.5 = 12.4'$ OUTSIDE MIDDLE ⅓ BY 3.65'



$A = 28.0 \times 35.0 = 980.0 \text{ FT}^2$

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONO #18 COMPUTED M. J. CHECKED BNM	PROJECT L. E. D #1 FILE NO. 800A DATE 9.74 PAGE 41 OF ___ PAGES

INTERMEDIATE WALL MONOLITH #18 (CONT'ED)

SOIL PRESSURE AT EDGE

$$\frac{e_{xx}}{d} = \frac{12.40}{35.0} = .356$$

$$\frac{e_{yy}}{b} = \frac{7.90}{28.0} = .282$$

$$C \simeq 12.0$$

$$f = 12 \cdot \frac{6081.0}{980} = 74.5 \text{ ksf}$$

$$FSOT = \frac{6081 \times 17.5}{2650 \times 20.5 + 1000 \times 20.5 + 1380 \times 22.0} = \frac{106{,}000}{102{,}600} = 1.03$$

$$\Sigma H = 2650 + 1{,}000 = 3{,}650^k$$

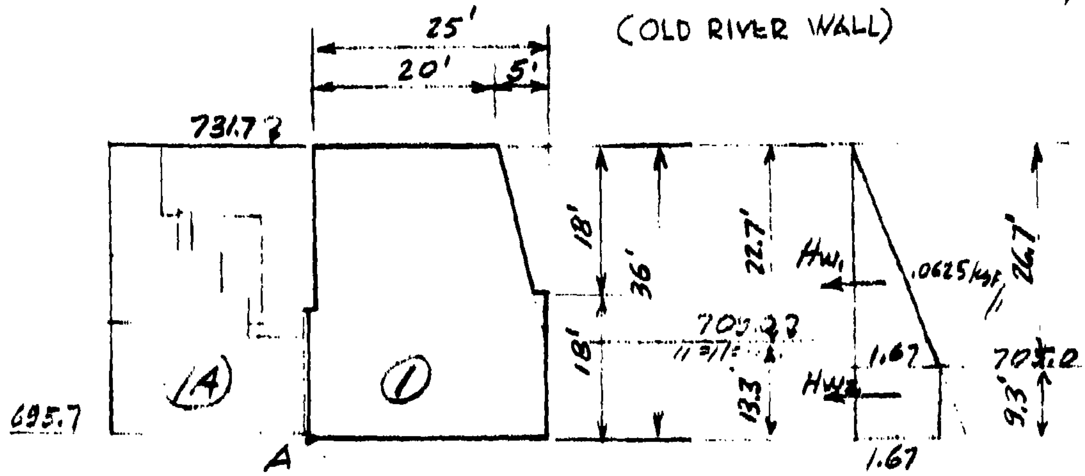
$$\Sigma V = 6081^k$$

$$FSS = \frac{6081 \times .625}{3650} = 1.04^*$$

*ACTUAL SLIDING WILL BE RESISTED BY SILL SLAB

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF RIVER WALL MONOLITH #1 DURING CONSTRUCTION	PROJECT L&D #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO. 800A
		DATE 1.75 PAGE 41 a OF PAGES

STABILITY OF MONOLITH #1 DURING CONSTRUCTION



$(25 \times 36 - 3.5 \times 18) \times .15 = 125^k$

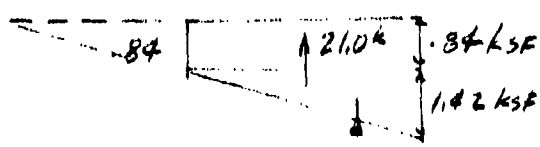
$-13.3 \times .0625 \times 25 \qquad = -21.$

$\Sigma Y = 104^k$

$900 \times .15 = 135 \times 12.5 = 1688$

$63 \times .15 = -10 \times 23.5 = 235$

$125^k \downarrow \qquad M_R = 1453$



$22.7 \times .0625 = 1.42$

$1.42 \times 25/2 = 17.8^k \qquad 17.8^k$

$H_{W1} = 1.67 \times 26.7 \times \frac{1}{2} = 22.2^k \qquad \times 18.20 = 406^{'k}$

$H_{W2} = 1.67 \times 9.3 = 15.6 \qquad \times 4.05 = 73$

$479^{'k}$

$\Sigma H = 37.8^k$

$21 \times 12.5 = 263$

$17.8 \times 16.75 = 298$

$\Sigma M_A = 479 + 17.8 \times 4.17 = 554.0$

$M_{OVERT} = 1040$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL MONOLITH #1, STABILITY DURING CONSTRUCTION COMPUTED M.I. CHECKED R.N.M.	PROJECT L&D #1 FILE No 800 A DATE 1.75 PAGE 41 b OF PAGES

STABILITY OF MONOLITH #1 DURING CONSTRUCTION (CONT'D)

$\Sigma V = 125.0 - 21.0 - 17.8 = 86.2^k$

$\Sigma M_{\mathbb{C}} = 554.0^{\,1k} \qquad \Sigma H = 37.8^k$

$e = \frac{554}{86.2} = 6.42' \qquad a = 6.08' \qquad 6.25 \qquad \left(\frac{L}{6} - e\right) = 4.16 - 6.42 = -2.26'$

1). $R = 95.0$ OUTSIDE MIDDLE $\frac{1}{3}$ BY 2.26'

2) $\frac{\Sigma H}{\Sigma V} = \frac{37.8}{86.2} = .438$

3). $f_{soil} = \frac{2 \times 86.2}{3 \times 6.08} = 9.50\ ksf$

4). $FSS = \frac{86.2 \times .55}{37.8} = 1.25$ *

$M_A = 478 + 17.8 \times 16.67 = \cancel{776} + 21 \times 12.5^{\,1k} = 1040$

5). $FSOT = \frac{\cancel{1014+12.5}}{\cancel{776}} = \cancel{1.67} = \frac{1453}{1040} = \underline{1.40}$

* A... SLIDING WILL BE IMPROVED, IF EXISTING PART OF MONOLITH 1A UNDER CONSTRUCTION WOULD BE COUNTED.

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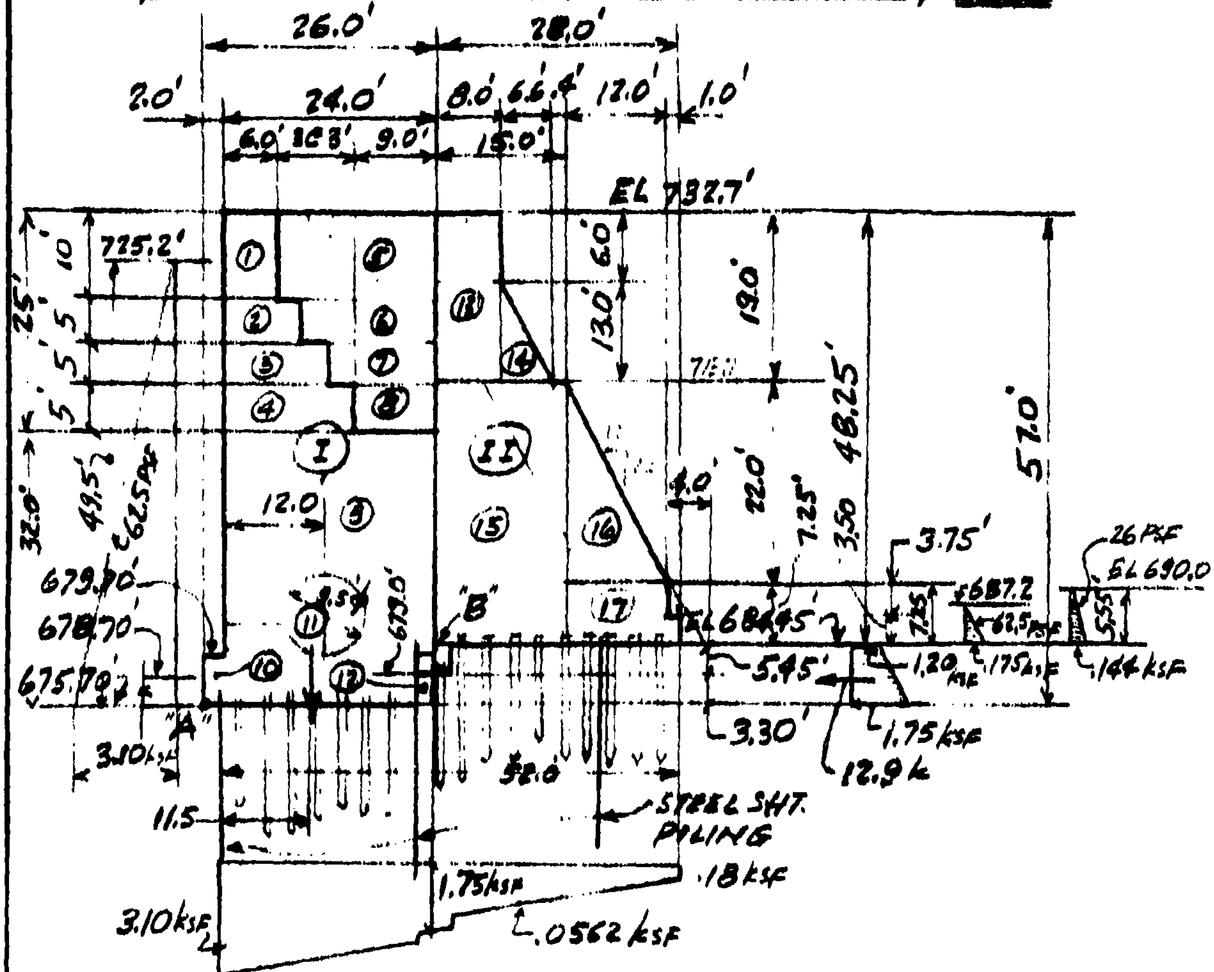
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY C TYPICAL RIVER WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE No 800A DATE 11.74 PAGE 42 OF ___ PAGES

TYPICAL RIVER WALL MONOLITHS 6-16



FOR FOUNDATION/PRESSURES SEE 50 g

FOR PILE LOADS SEE p. 50 a and p. 50 b

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY	PROJECT L&D #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO 800A
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TYPICAL RIVER WALL MONOLITH

	LOADS IN KIPS	V ↓	V ↑	H ←	H →	ARM	MA ↻	MA ↺
C_1	6.0×10×.15	9.0				5.0	45.0	
C_2	5.0×9.0×.15	6.8				6.5	44.2	
C_3	5.0×12.0×.15	9.0				8.0	72.0	
C_4	5.0×15.0×.15	11.3				9.5	107.3	
C_9	32.0×24.0×.15	115.0				14.0	1615.0	
C_{10}	2.0×4.0×.15	1.2				1.0	1.2	
C_{11}	π×4.8²×.15		10.8			14.0		151.5
C_{12}	4.0×3.0×.15		1.8			24.5		45.2
E_5	10.0×18.0×.115	20.8				17.0	354.0	
E_6	5.0×15.0×.115	8.6				18.5	159.0	
E_7	5.0×12.0×.115	6.9				20.0	138.0	
E_8	5.0×9.0×.115	5.2				21.5	111.5	
	Σ	193.8	12.6				2647.2	196.7'k

$\Sigma V = 181.2^k \downarrow$

$\Sigma M = 2450.5'^k$ ↻

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY	PROJECT L&D #1
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TYPICAL RIVER WALL MONOLITH (CONT'ED)

	LOAD IN KIPS	V ↓	V ↑	H ←	H →	ARM	M_B ↻	M_B ↺
C_{13}	8.0 × 19.0 × .15	22.8				4.0	91.4	
C_{14}	6.6 × 6.5 × .15	6.4				10.2	65.3	
C_{15}	15.0 × 29.25 × .15	66.0				7.5	496.0	
C_{16}	12.0 × 11.0 × .15	19.8				19.0	377.0	
C_{17}	12.5 × 7.25 × .15	13.6				21.25	290.0	
	Σ	128.6 k					1319.7 'k	
H_{W_2}	3.10 × 49.5/2				77.0	16.5	M_B ↻ 1270.0	

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY COMPUTED M.J. CHECKED R.N.M.	PROJECT L & D #1 FILE No. 800 A DATE 11.74 PAGE 45 OF ___ PAGES

TYPICAL RIVER WALL MONOLITH (CONT'ED)

MONOLITH (I) (SHT #5)

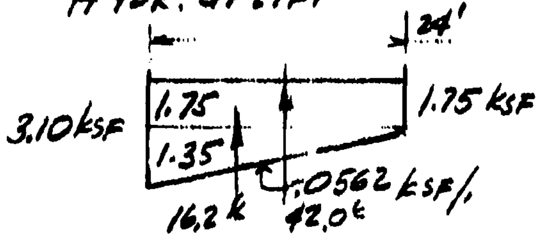
$\Sigma V = 181.2^k$ (WITHOUT UPLIFT)

$\Sigma M_A = 2450.5$

LOCATION OF RESULTANT (VERT.)

$\frac{2450.5}{181.2} = 13.50'$ (DISTANCE FROM "A")

HYDR. UPLIFT



$.0562 \times 24 = 1.35$

$1.75 \times 24.0 = 42.0^k$
$1.35 \times 24.0/2 = 16.2^k$
$\} 58.2^k$

MONOLITH (II) (SHT #5)

$\Sigma V = 128.6^k$ (WITHOUT UPLIFT)

$\Sigma M_B = 1319.7'^k$

LOCATION OF RESULTANT $\frac{1319.7}{128.6} = 10.3'$ (DIST. FROM "B")

HYDROST. UPLIFT

$.18 \times 28 = 5.0^k$
$1.02 \times 14 = 14.3^k$
$\} 19.3^k$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY	PROJECT L&D #1
	COMPUTED M.J. CHECKED R.N.M.	FILE No. 800A
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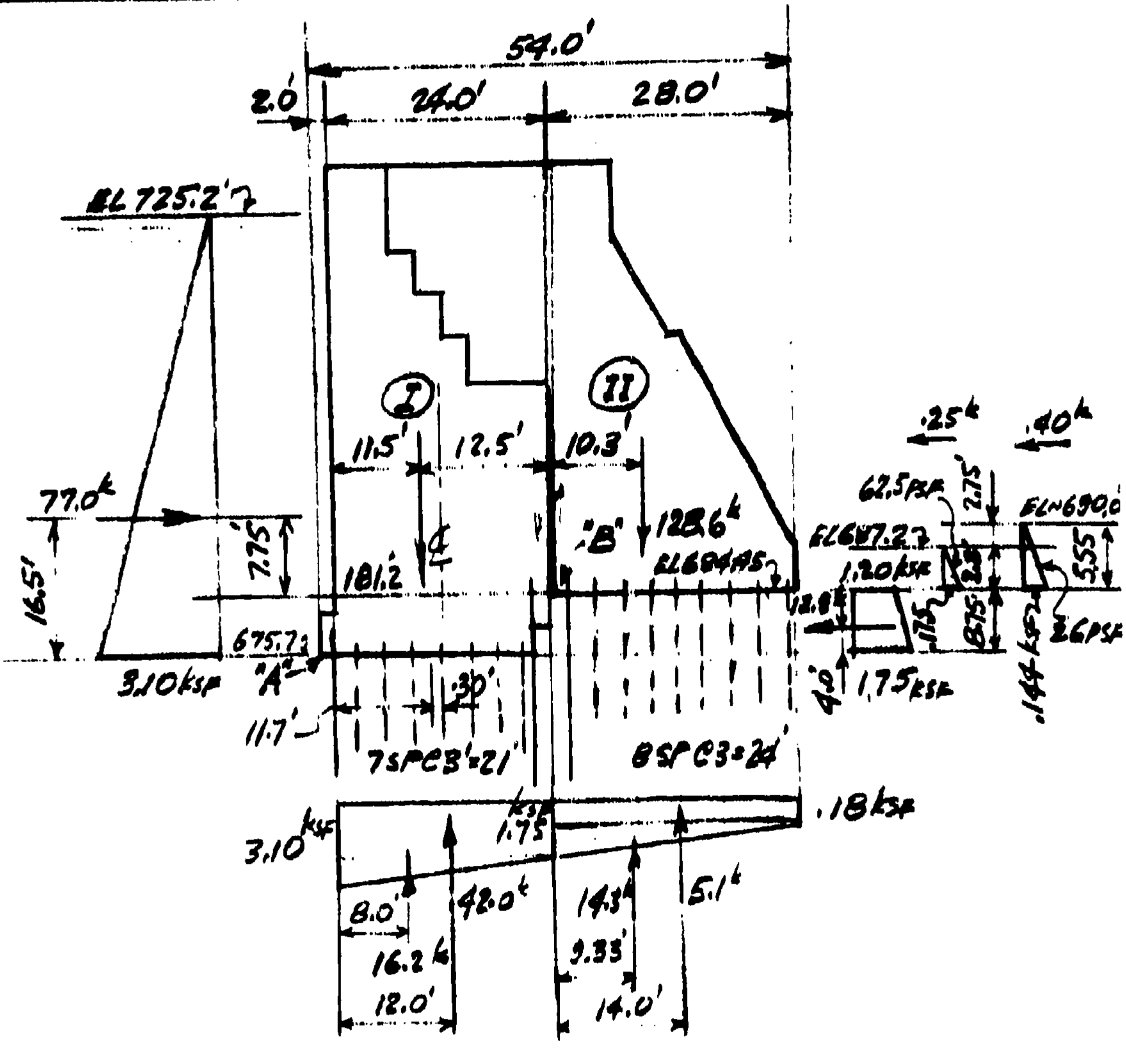
TYPICAL RIVER WALL MONOLITH (CONT'ED)



$$W.S.\ EL.\ @\ ``B" = 675.7 + \frac{1}{.0625}\left[\left(\frac{3.10 - .18}{52}\right)28 + .18\right] = 703.7'$$

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY	PROJECT LED #1
	COMPUTED M.T. CHECKED R.N.M.	FILE No. 800 A
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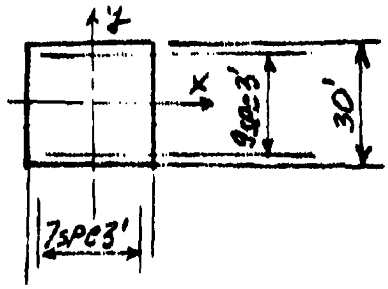
TYPICAL RIVER WALL MONOLITH (CONT'D)

MONOLITH (I) FOUNDATION PROPERTIES

PILES C 3.0' SPACING   7 ROWS C 3' = 21.0'

FOR 30' WIDE MONOLITH × 24' DEEP



$$I_{YY} = 20 \times 10.5^2 + 20 \times 7.5^2 + 20 \times 4.5^2 + 20 \times 1.5^2 = 3793$$

$$S_{YY} = \frac{3793}{10.5} = 362 \quad \text{FOR 1-0 WIDTH } S = 12.0$$

MONOLITH (II) FOUNDATION PROPERTIES

FOR 30' WIDE × 28.0' DEEP MONO.

$$I_{YY} = 20 \times 12.0^2 + 20 \times 9.0^2 + 20 \times 6.0^2 + 20 \times 3.0^2 = 5400$$

$$S_{YY} = \frac{5400}{12} = 450 \quad \text{FOR 1-0 WIDTH } S = 15.0$$

MONO'S (I) & (II) COMBINED

$$I_{YY} = 20 \times 3.0^2 + 20 \times 6.0^2 + 20 \times 9.0^2 + 20 \times 12.0^2 + 20 \times 15.0^2 + 20 \times 18.0^2$$
$$+ 20 \times 21.0^2 + 20 \times 24.0^2 = 36670$$

$$S_{YY} = \frac{36670}{24} = 1550 \quad \text{FOR 1-0 WIDTH } S = 51.7$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY	PROJECT L & D #1
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TYPICAL RIVER WALL MONOLITH (CONT'ED)

MONOLITH (I), FOUNDATION LOADING

181.2 × 11.5	= 2084
− 16.2 × 8.0	= − 130
− 42.0 × 12.0	= − 504
~~127.6~~ k 123.	1450

$X_1 = \frac{1450.0}{123.0} = 11.80'$ (13.7' FROM "A")

$M_{℄} = 77.0 \times 16.5 - 123.0 \times 0.2 - 12.9 \times 4.0 = 1194.4^{1k}$

$e = \frac{1194.4}{123.0} = \underline{9.70'}$ $a = 2.30'$ $\frac{L}{2} - e = -5.7'$

$\frac{\Sigma H}{\Sigma V} = \frac{64.1}{123} = .52$

FSS = 1.05

AREA LOADING,

$A = 24.0 FT^2$

SOIL PRESSURE $f = \frac{2}{3} \times \frac{\cancel{127.6}\ 123}{2.30} = \underline{\cancel{37.1}\ 35.6\ KSF}$

PILE LOADING,

$P = \frac{123.0}{80/30} \pm \frac{1194.4}{12} = 46.0 \pm 99.0$

$P_{MAX} = 145.0^k$

$P_{MIN} = -53.0^k$

FOR COMBINED PILE LOADING, SEE SHT # 9

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY COMPUTED M.J. CHECKED R.V.M.	PROJECT LED #1 FILE No 800A DATE 11.74 PAGE 49 OF ___ PAGES

TYPICAL RIVER WALL MONOLITH (CONT'D)

MONOLITH (II), FOUNDATION LOADING

$128.6 \times 10.30 = 1325.0^{'k}$

$-14.3 \times 9.33 = -134.0$

$\underline{-5.1} \times 14.00 = \underline{-71.3}$

$109.2^k \qquad 1120.0^{'k}$? (M_B)

$X_B = \dfrac{1120.0}{109.2} = 10.25' \qquad 14.0 - 10.25 = 3.75$

$M_{\text{℄}} = 109.2 \times 3.75 + .175 \times \dfrac{2.8^2}{2} + .144 \times \dfrac{5.55^2}{2} = 415.0^{'k}$

$e = \dfrac{415.0}{109.2} = 3.80' \qquad S = \dfrac{1.0 \times 28.0^2}{6} = 130.0 \qquad \dfrac{L}{6} - e = -.86'$

AREA LOADING

$\dfrac{.175 \times 2.8}{2} = .24$

$f = \dfrac{109.2}{28} \pm \dfrac{415.0}{130.0} = 3.92 \pm 3.20$

$\dfrac{.144 \times 5.55}{2} = .4$

$f_{MAX} = \underline{7.12}$ ksf $\qquad f_{MIN} = \underline{0.72}$ ksf

PILE LOADING

$P = \dfrac{109.20}{80/30} \pm \dfrac{415}{15.0} = 41.2 \pm 27.7$

$P_{MAX} = 68.9^k$

$P_{MIN} = 13.5^k$

FOR COMBINED PILE LOADING, SEE SHT # 9

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE No. 800A DATE 11.74 PAGE 50 OF ___ PAGES

TYPICAL RIVER WALL MONOLITH (CONT'ED)

COMBINED PILE LOADING FOR MONO'S (I) & (II)

$M_{(II)} = 415.0'^k$

$77.0 \times 16.5 \quad = 1270$

$-12.9 \times 4.0 \quad = -51.6$

$64.1^k \qquad 1218.4$

$y = \frac{1218.4}{64.1} = 19.1'$

MOMENT C EL 684.45

$64.1 \times (19.0 - 8.75) - 415.0 = 243.3'^k \qquad \Sigma H = 64.1$

PILE LOADING

$P = \frac{127.6}{8/3} - \frac{243.0}{51.7} = 48.0 - 4.7$

$P_{MAX} = 43.30^k/\text{PILE}$

$P = \frac{107.1}{9/3} + 4.7$

$P_{MIN} = 35.7 + 4.7 = 40.4^k/\text{PILE}$

FOR PILE LOADS WHERE STEEL SHEET PILING IS NOT CONSIDERED, SEE P, 50a

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT TYPICAL RIVERWALL-EXISTING - NORMAL CONDITION	PROJECT LOCK & DAM
	COMPUTED R.N.M. CHECKED JJ	FILE No. 800 A
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TYPICAL RIVERWALL MONOLITH
EXISTING CONDITION
NORMAL LOADING

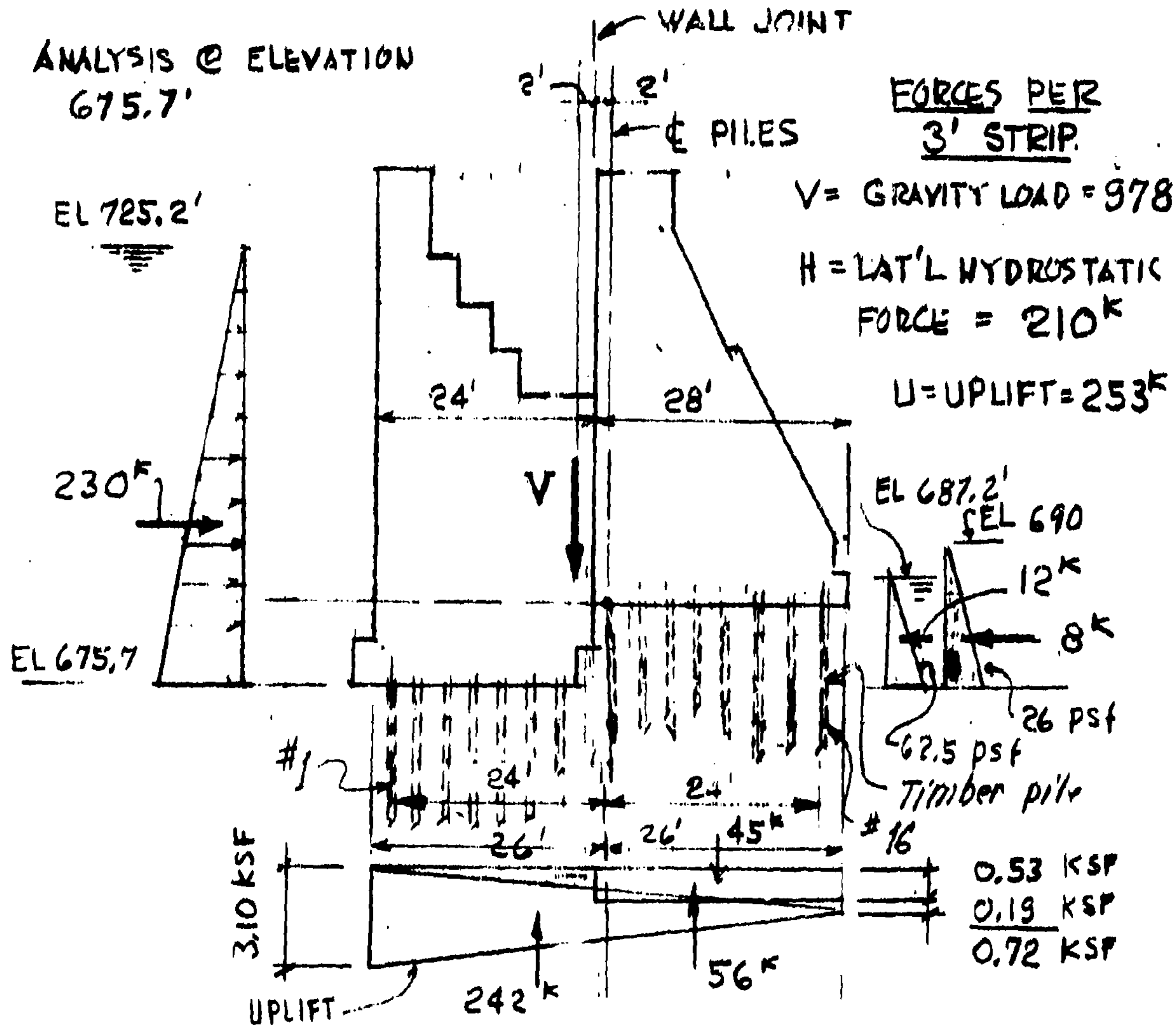
ANALYSIS @ ELEVATION 675.7'

FORCES PER 3' STRIP.

V = GRAVITY LOAD = 978^K

H = LAT'L HYDROSTATIC FORCE = 210^K

U = UPLIFT = 253^K



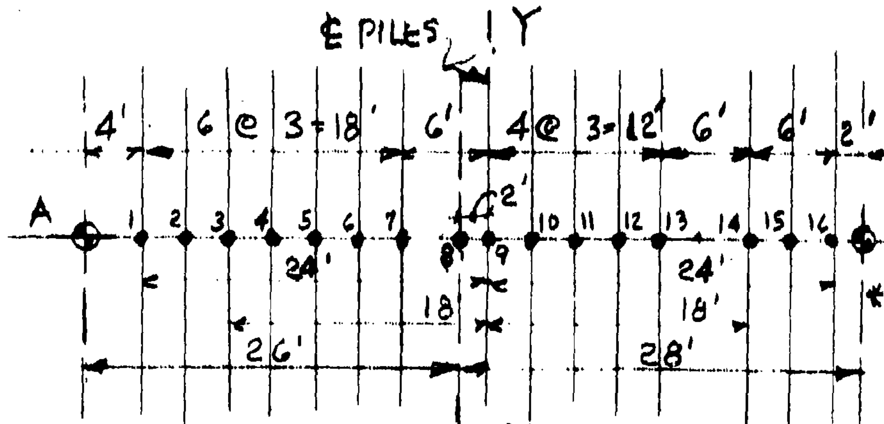
1) MAX BEARING ON PILES = 50^K (PILE #16)

2) HORIZONTAL PILE LOAD = 13^K

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT TYPICAL RIVERWALL - EXISTING - NORMAL LOADING COMPUTED R.N.M. CHECKED [illegible]	PROJECT L & DAM #1 FILE NO 800 A DATE 3/75 PAGE 50 b OF ___ PAGES

TYPICAL RIVERWALL
EXISTING CONDITION
NORMAL LOADING

PILE FOUNDATION PROPERTIES**



** C.G. OF PILE IS APPROXIMATE BUT WITH SUFFICIENT ACCURACY.

$$I_{Y\text{-}Y} = 2(24)^2 + 2(21)^2 + 2(18)^2 + 15^2 + 2(12)^2 + 2(9)^2 + 2(6)^2 + 3^2 + 2^2$$

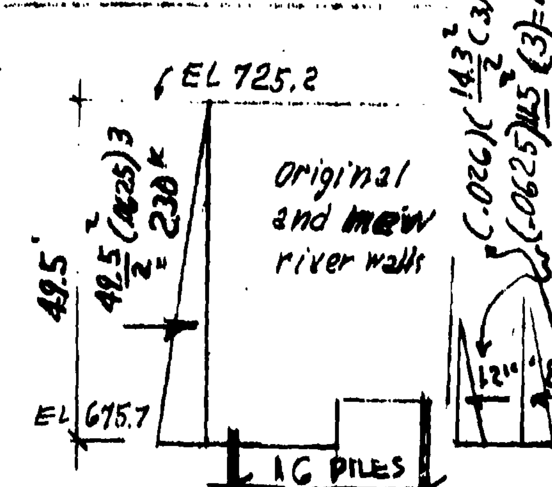
$$I_{Y\text{-}Y} = 3442'^4$$

$$S = \frac{3442}{24} = 143'^3$$ PER 3 FEET LONGITUDINAL

Number of piles = 16

HORIZONTAL LOAD PER PILE

$$P_H = \frac{230-30}{16} = 13^K \text{ (Approx)}$$



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT TYPICAL RIVERWALL – EXISTING – NORMAL LOADING COMPUTED R.N.M. CHECKED JJ	PROJECT L & D #1 FILE NO 800 A DATE 3/'75 PAGE 50C OF ___ PAGES

TYP. RIVERWALL MONOLITH, EXISTING CONDITION, NORMAL LOADING

GRAVITY LOAD, V & M_{Y-Y}

REFERENCE Pg 42

TAKEN AT ELEVATION 684.45'

	GRAVITY LOAD	H	V ↓ ⊕	ARM A	ARM Y-Y	M_A	M_{Y-Y} ⊕
1	6 x 10 x .15		9.0	5.0		45.0	
2	5 x 9 x .15		6.8	6.5		44.2	
3	5 x 12 x .15		9.0	8.0		72.0	
4	5 x 15 x .15		11.3	9.5		107.3	
5	10 x 18 x .115	192.8	20.8	17.0	2644	354.0	
6	5 x 15 x .115		8.6	18.5		159.0	
7	5 x 12 x .115		6.9	20.0		138.0	
8	5 x 9 x .115		5.2	21.5		111.5	
9	32 x 24 x .15		115.2	14.0		1613	
10a	24 x 8.75 x (-.063)		-13	13.0		-169	
11	π(4.8)² x (-.15)		-10.8	14.0		-151	
12	4 x 3 x (-.15)		-1.8	24.5		-44	
13			22.8	30.0		684	
14		128.6	6.4	36.2		~~398~~ 232	
15			66.0	33.5	4661	2211	
16			19.8	45.0		891	
17			13.6	47.3		643	
	ARM Y-Y = ARM A - 28'	TOTAL =	295.8	(23.47) 24.0	-4.53'	6941	1340 ~~1186~~

x 3 ft. strip of wall ...... x 3

887.^{K} .... $-4020'^K$

CONC. BELOW EL 684.5:

$\Delta V = 24 \times 8.45 \times 3 \times .15$ 91.3   x 14'

978.3^K say $\Delta M_{Y-Y} = -1278$

$\Sigma V_{GRAVITY} = 978^K$ $\Sigma M_{Y-Y\,GRAVITY} = 5298'^K$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT TYPICAL RIVER WALL EXISTING – NORMAL LOADING	PROJECT L & D # 1
	COMPUTED R.N.M. CHECKED JJ	FILE NO. 800 A
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TYPICAL RIVER WALL MONOLITHS EXISTING, NORMAL LOADING CONDITION

MAX. LOAD ON PILES @ EL. 675.7

LATERAL PRESSURES: $M_{GRAVITY} = 5298$

$\frac{(725.2-675.7)^2}{2} \times .0625 \times 3 = +230^k \quad \times 16.5 \quad 3795'^k$

$\frac{(687.2-675.7)^2}{2} \times .0625 \times 3 = -12^k \quad \times 3.8 \quad -46$

$\frac{(690-675.7)^2}{2} \times .026 \times 3 \quad -8^k \quad \times 4.8 \quad -38$

$\Sigma H = 210^k \quad M_{\Sigma H} = 3711'^k$

UPLIFT:

$\frac{3.10 \times 52}{2} \times 3 = +242^k \quad \times 8.7 = +2105$

$\frac{0.72 \times 52}{2} \times 3 = +56 \quad \times 8.7 = -487$

$0.53 \times 28 \times 3 = -45 \quad \times 12 = +540$

$U = 253^k \quad M_u = 2158'^k$

PILE LOAD:

$\Sigma V = 978 - 253 = 725^k \quad \Sigma M_{\text{¢}} = +571'^k$

$\frac{725}{16} - \frac{571}{143} = 41.3$ say 42^k – P VERT ON PILE # 1

$\frac{725}{16} + \frac{571}{143} = 49.3$ SAY 50^k – P VERT. ON PILE # 16

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT TYPICAL RIVERWALL EXISTING - NORMAL LOADING COMPUTED JI CHECKED R.N.M.	PROJECT L & D #1 FILE NO 802A DATE 4/75 PAGE 50f OF ___ PAGES

FOUNDATION PRESSURES - VERTICAL LOAD TRANSFER BETWEEN I & II

Combine I & II Loads (Ref. p 42 - 50)
per linear foot

I ΣV	181.2	2451	
II ΣV	128.6	4603	$\left(\frac{1219}{128.6}+26\right)128.6$
I Uplift	-16.2	- 162	$\left(\frac{24.0}{2}-2\right)16.2$
I	-42.0	- 588	$\left(\frac{28.0}{2}+2.0\right)42$
II "	- 5.0	- 200	$\left(\frac{28}{2}+26.0\right)5$
II "	- 14.3	- 555	$\left(\frac{28}{2}+26\right)14.3$
ΣV_{found} =	232.3	5659	$\frac{5659}{232.3}=24.36$

H	77.0	1271
E	- .4	- 4
H	- [illegible]	- [illegible]
H	- 12.[illegible]	- 52
ΣH =	63.5	1212

$$\bar{X} = \frac{5659 + 1212}{232.3} = 29.58'$$

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT TYPICAL RIVERWALL EXISTING - NORMAL LOADING	PROJECT L&D M 1
	COMPUTED JJ CHECKED	FILE NO 800A
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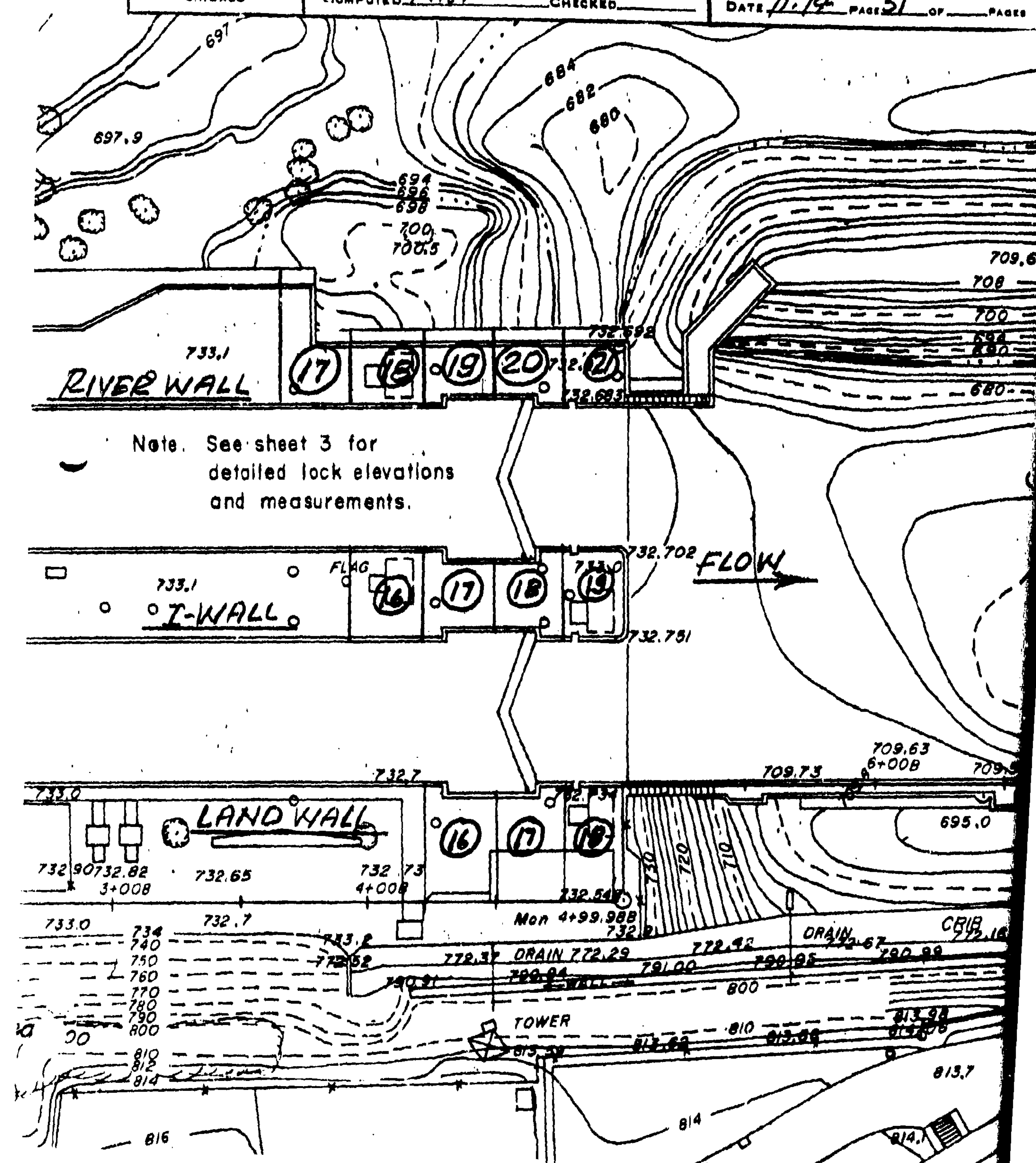
$$e = \frac{54.0}{2} - 29.58' = -2.58' \qquad \left(\frac{L}{6} - e\right) = 6.42'$$

$$p = \frac{232.3}{54.0}\left(1 \pm \frac{6 \times 2.58}{54.0}\right) = \begin{cases} \underline{\underline{5.54}} \text{ ksf max} \\ \underline{\underline{3.07}} \text{ ksf min} \end{cases}$$

$\Sigma H = 63.5$ $\quad \frac{\Sigma H}{\Sigma V} = .273 \quad$ F.S.S. = 2.01

$\Sigma V = 232.3$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL MONOLITHS #19, #20 COMPUTED M.J. CHECKED	PROJECT LED #1 FILE NO 800A DATE 11.74 PAGE 51 OF PAGES



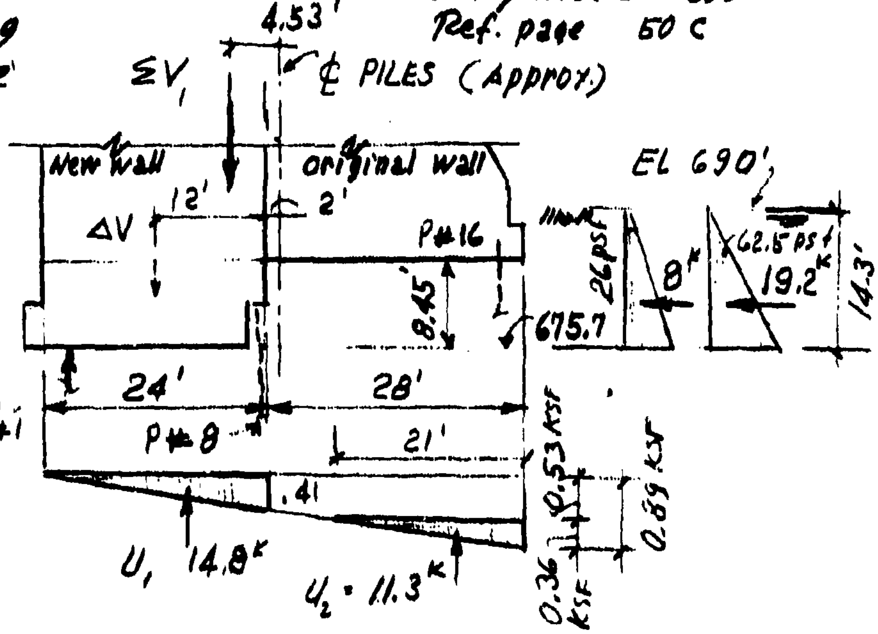
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT TYPICAL RIVERWALL – LOCK EMPTY COMPUTED R.N.M. CHECKED JJ	PROJECT L & D #1 FILE NO. 800A DATE 3/'75 PAGE 50e OF ___ PAGES

RIVERWALL TYP. MONOLITH
CONSTRUCTION/MAINTENANCE

Analysis taken at el. 675.7'
G.S. & W.S. El. 690'
Ref. page 50 C

Maximum bearing load on extreme "lockside" pile.

Assume complete transfer of vert. load between original and new riverwall.



$$\Delta V = 24 \times 8.45 \times 3 \times .15 = 91.3^K \quad \times(-14) = -1278$$
$$\Sigma V_1 = 887.0^K \quad \times(-4.53) = -4020$$
$$U_1 = -14.8^K \quad \times(-10) = +148$$
$$U_2 = -11.3^K \quad \times(+19) = -215$$

$$\Sigma V = \underline{952.2}^K \downarrow$$
$$\Sigma H = \underline{27.2}^K \leftarrow \quad \times \frac{14.3}{3} = -\underline{130}$$

$$\Sigma M_{¢} = -5495'^K$$

Force per pile, $P = \frac{\Sigma V}{n} \pm \frac{\Sigma M_{¢}}{S}$

$$= \frac{952.2}{16} + \frac{5495}{143} = \underline{98}^K \quad \text{Pile \#1}$$

$$P = 59.5 - \frac{5495}{143} = \underline{21}^K \quad \text{Pile \#16}$$

$$P_H = \frac{27.2}{16} \approx \underline{2}^K$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITION OF STABILITY @ RIVER WALL	PROJECT LOCK & DAM #1
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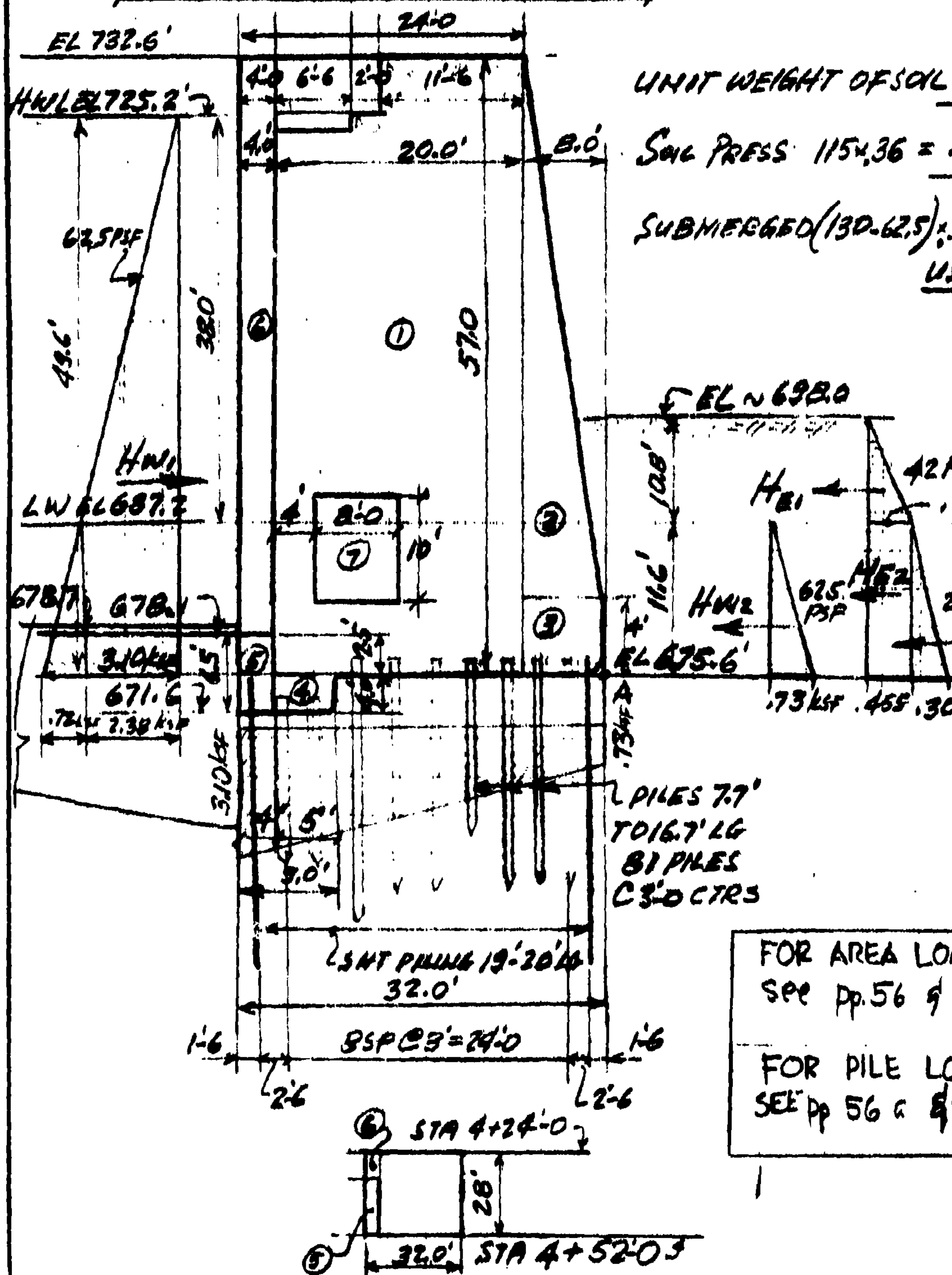
RIVER WALL MONOLITH #19

UNIT WEIGHT OF SOIL 115 PCUF

SOIL PRESS 115×.36 = 42 PSF

SUBMERGED (130-62.5)×.36 ≈ 25 PSF
USED 26 PSF



FOR AREA LOADING See pp. 56 & 58

FOR PILE LOADS, SEE pp 56 a & 57 a

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITION OF STABILITY @ RIVERWALL	PROJECT LED #1
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RIVERWALL MONOLITH #19 (CONT'ED)

	LOADS IN KIPS	VERT. ↓	VERT. ↑	HORIZ. →	HORIZ. ←	ARM	MOM_A ↻	MOM_A ↺ ('k)
C1	57.0×20.0×28×.15	4790				18.0		86200
C2	53.0×4.0×28×.15	890				5.33		4740
C3	8.0×4.0×28×.15	134				4.0		538
C4	5.0×4.0×28.0×.087	49				25.5		1250
C5	6.5×4.0×19.5×.087	43				30.0		1290
C8	47.×4×19.5×.0625	230				30.0		6900
C6	61×4.0×8.5×.15	312				30.0		9360
		Σ 6448						Σ 110,280
C7	80.0×28×.088		200			20.0	4,000	
HW1	3.10×24.8×28			2150		16.53	35,600	
HW2	.730×5.8×28				118.0	3.88		460
HE1	.328×3.9×28				69.0	17.0 (15.1)		1170 (1040)
HE2	.328×11.6×28				147.0	5.8		855
HE3	.151×11.6×28				49.0	3.88		190
	Σ	6448	200.0	2150 →	383 ←		39,600	112,860
W1	AVERAGE PRESS. @ LOCKSIDE		1189.0 k	(SEE NEXT SHT.)			ΣM = 73260 'k ↺	
W2	MAX PRESS. @ LOCKSIDE		1717.0 k	(" " ")				

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITION OF STABILITY @ RIVER WALL	PROJECT LED #1
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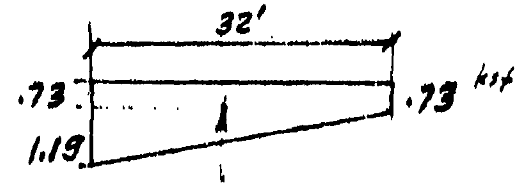
RIVER WALL MONOLITH #19 (CONT'ED)

HYDROSTATIC PRESSURE @ BOTTOM

1). LOCKSIDE AVERAGE

$$\frac{3.10+.73}{2} = 1.92\ ksf$$

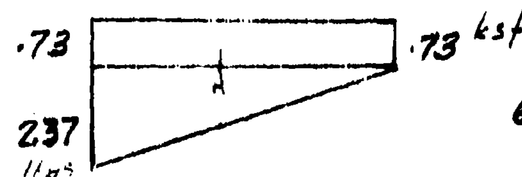
$$\left.\begin{aligned} 32 \times 28 \times .73 &= 655^k \\ 32 \times 14 \times 1.19 &= 534^k \end{aligned}\right\} 1189^k$$



$$M_A = 655 \times 16 + 534 \times 21.33 = 10450 + 11390 = 21{,}840'^k$$

$$\Sigma M_A = 66{,}360 - 21840 = 44{,}520'^k$$

2). LOCKSIDE MAXIMUM



$$655 + 1.185 \times 32 \times 28 = 1717^k$$

1062

$$M_A = 10{,}450 + 1.185 \times 32 \times 28 \times 21.33 = 10{,}450 + 22{,}700$$

$$M_A = 33.150'^k$$

RIVERWALL MONOLITH #19 (CONT'D)

PILE LOADING FOR AVERAGE HYDROSTATIC LOAD↑,

(LOCKSIDE AVERAGE LOAD↑) (AVERAGE UPLIFT)

$V = 6248 - 1189 = 5059^k$

$M_A = 73{,}260 - 21840 = 51{,}420'^k$

$a = \frac{51420}{5059} = 10.16'$ $e = \frac{32.0}{2} - 10.16 = \underline{5.84'}$

$M_{℄} = 5059 \times 5.84 = 29{,}500'^k$

SHEET PILE LOADING

$P_{SP} = \frac{5059}{3 \times 99} \pm \frac{29500}{3 \times 600} = 17.03 \pm 16.4 /FT \begin{cases} 33.4 \\ 0.6 \end{cases}$

FOR 15" SHT PILES, $P_{MAX} = 41.8^k$ $P_{MIN} = 0.8^k$

MAX LOAD ON TIMBER PILES

$I_{xx} = 8690$

$S = \frac{8690}{12.0} = 725$

$P = \frac{5059}{99} \pm \frac{29{,}500}{725} = 51.10 \pm 40.7$

$P_{MAX} = 91.8^k$ $P_{MIN} = 10.4^k$

$\overrightarrow{H} = 2150 - 383 = 1767^k$ OR $\overrightarrow{17.8}$ EA. PILE

FOR PILE LOADS (WITHOUT STEEL SHT PILING) SEE PAGE 56 a

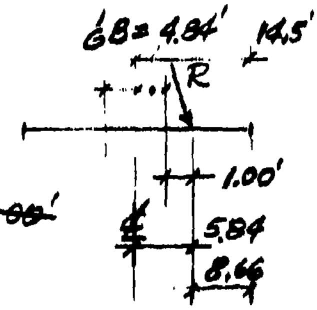
FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY AT RIVER WALL COMPUTED M. J. CHECKED R.N.M.	PROJECT L&D #1 FILE No. 800A DATE 10.74 PAGE 56 OF ___ PAGES

RIVER WALL MONOLITH #19 (LOCKSIDE AVERAGE), CONT'D

CHECK AREA LOADING, ASSUMING AREA BETWEEN SHEET PILES

$A = 29.0 \times 28.0 = 812\ FT^2$



$a = 10.16' \quad e = 5.84'$

$5.84 - 5.33 = 0.51'$

1). RESULTANT OUTSIDE MIDDLE 1/3 BY ~~1.00'~~

2). $f_{SOIL} = \frac{2}{3}\ \frac{5059}{28 \times \cancel{8.66}\ 10.16} = \cancel{13.90}\ 11.86$ KSF

3). $\frac{\Sigma H}{\Sigma V} = \frac{1767}{5059} = 0.350$

4) $FSS = \frac{5059 \times .55}{1767} = 1.57$

5). $FSOT = \frac{112860}{61440} = 1.84$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY – PILE LOAD	PROJECT L & D #1
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RIVERWALL MONOLITH NO. 19

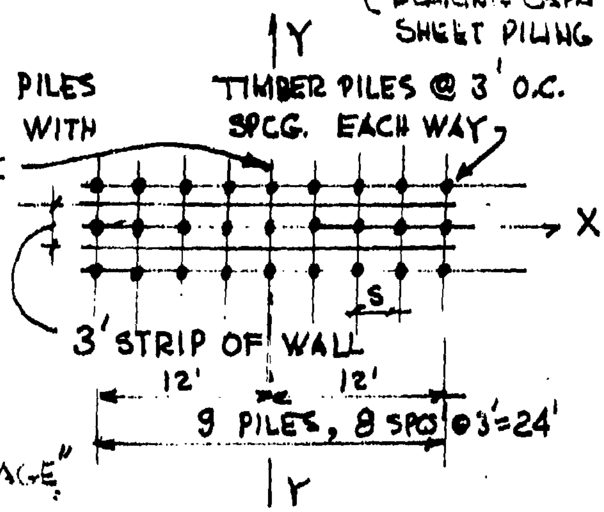
EXISTING, NORMAL LOADING CONDITION

PILE LOADING, ASSUMING THAT THE TIMBER PILES SUPPORT ALL THE LOAD

(BEARING CAPACITY OF STEEL SHEET PILING NOT CONSIDERED)

ASSUME ℄ PILES COINCIDES WITH ℄ BASE

TIMBER PILES @ 3' O.C. SPCG. EACH WAY



$2(12)^2 = 288$
$2(9)^2 = 162$
$2(6)^2 = 72$
$2(3)^2 = 18$
$I_{y\text{-}y} = 540\ ft^4$
$S = 45\ ft^3$

"LOCK SIDE AVERAGE"

$\Sigma V = 5059 \times \frac{3}{28} = 542^k \downarrow$ (Rept. Page 55 ✓)

$\Sigma M_{℄} = 29{,}500 \times \frac{3}{28} = 3160'^k$ } PER 3' STRIP OF WALL

$\Sigma H = 1767 \times \frac{3}{28} = 189^k \rightarrow$

MAXIMUM LOAD ON TIMPER PILES:

$$P = \frac{542}{9} + \frac{3160}{45} = 60 + 70 = \underline{130}^k \text{ (MAX) /PILE}$$

MINIMUM LOAD ON TIMBER PILES $= 60 - 70 = \underline{-10}^k$ (MIN)/PILE

HORIZONTAL LOAD PER PILE $= \frac{189}{9} = \underline{21}^k$ /PILE

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY (RIVER WALL	PROJECT L&D #1
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RIVERWALL MONOLITH #19 (CONT'ED)

MAXIMUM LOADING ON PILES (LOCKSIDE MAXIMUM)

$\Sigma V = 6248 - 1717 = \underline{4531}^k$

$M_A = 73260 - 33150 = 40110^{\prime k}$

$a = \dfrac{40110}{4531} = 8.85'$ $\quad e = \dfrac{32.0}{2} - 8.85 = 7.14'$

$M_{\mathbb{C}} = 7.14 \times 4531 = 32350^{\prime k}$

$I_{xx} =$	18×14.5^2	212	3820
	18×12.0^2	144	2600
	18×9.0^2	81	1460
	18×6.0^2	36	648
	18×3.0^2	9	162
			8690

$I_{xx} = 8690\ FT^4$

$S_{xx} = \dfrac{8690}{14.50} = 600.0\ FT^3$

PAGE 57a FOR PILE LOADS (W/O STEEL SHT. PILING

MAX LOADS ON SHEET PILING

$P = \dfrac{4531}{99} \pm \dfrac{32350}{600} = 45.60 \pm 54.00 \begin{cases} 99.60^k \\ -8.40^k \text{ TENS.} \end{cases}$

FOR 15" SHT. PILES $P_{max} = 41.6^k$/PILE $\quad P_{MIN} = -3.5^k$/PILE (TENS.)

MAX LOAD ON TIMBER PILES

ASS'D MP101 $A = 10.3\ IN^2$ $f_{ALL.}^{MAX} = 25.0\ KSI$

MAX. $P = 25.8^k$

$I_{xx} = 8690\ FT^2$ $\quad S_{xx} = \dfrac{8690}{12} = 725\ FT^3$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY - PILE LOAD	PROJECT L & D #1
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RIVER WALL MONOLITH NO. 19

EXISTING, NORMAL LOADING CONDITION

PILE LOADING

ASSUMPTION THAT PILES SUPPORT ALL LOAD

"LOCK SIDE MAXIMUM." - Reference pgs 56 & 57

$\Sigma V = 4531 \times \frac{3}{28} = 486^k$ SECT. MOD., $S = 45\ ft^3$

$\Sigma M_{\mathbb{C}} = 32,350 \times \frac{3}{28} = 3466\ '^k$

$P_{MAX.} = \frac{486}{9} + \frac{3466}{45} = 54 + 77 = \underline{131}^k$

$P_{MIN} = \text{-------} = 54 - 77 = -\underline{23}^k$

$P_H = 21^k$

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RIVERWALL MONOLITH #19 (CONT'ED)

MAX LOAD ON TIMBER PILES (LOCKSIDE MAXIMUM) (CONT'ED)

(SEE P. 57a)

$P = 45.6 \pm \frac{32350}{725} = 45.6 \pm 44.6$ $\qquad H = 1767^k$

$P_{MAX} = 90.2^k \downarrow \quad P_{MIN} = +1.0^k \downarrow \qquad H/\text{PILE} = 17.8^k \rightarrow$

CHECK FOUNDATION LOADING, ASSUMING FULL AREA ~~(BETWEEN SHEET PILING)~~ SUPPORTING ALL LOADS (AREA LOADING)

$A = 29.0 \times 28 = 810 \text{ FT}^2$

$e = 7.14' \quad a = \cancel{14.5}\ 16 - 7.14 = \cancel{7.36}\ 8.86'$

1). RESULTANT OUTSIDE MIDDLE $\frac{1}{3}$ BY $7.14 - \frac{\cancel{29.0}\ 32}{6} = \cancel{2.30}\ 1.80$

2). $f_{SOIL} = \frac{2 \times 4531}{3 \times 28 \times \cancel{7.36}\ 8.86} = \cancel{14.6}\ 12.17 \text{ KSF}$

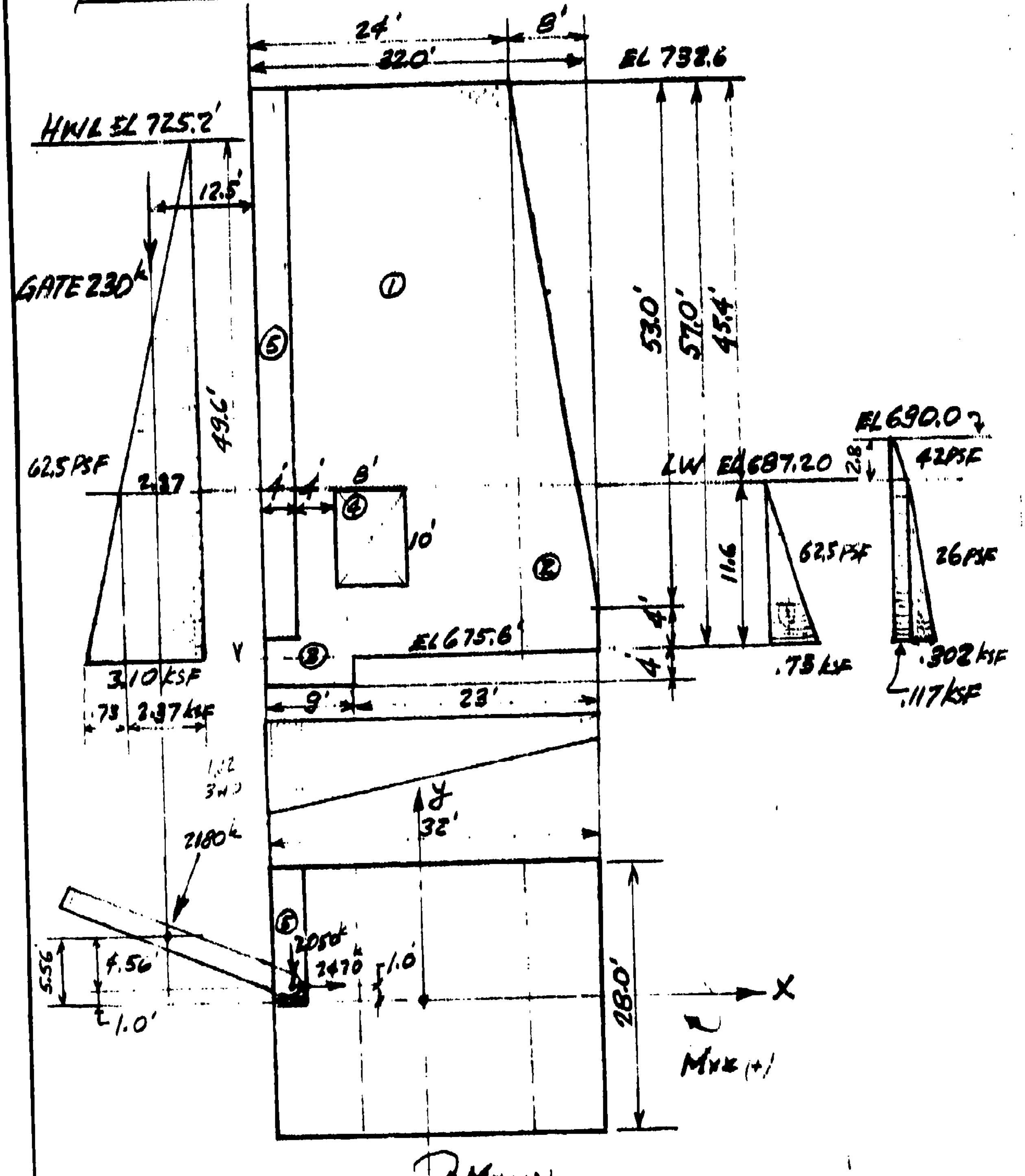
3). $FSS = \frac{4531 \times .55}{1767} = 1.41$

4). $\frac{\Sigma H}{\Sigma V} = \frac{1767}{4531} = \cancel{.34}\ .39$ (FOR $f = .55$ & $FSS = 1.5$ $\frac{\Sigma H}{\Sigma V} = .367$)

5). $FSOT = \frac{112,860}{39600 + 33150} = 1.55$
72750

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY @ RIVERWALL COMPUTED M. J. CHECKED R.N.M.	PROJECT LED #1 FILE NO. 800A DATE 10.74 PAGE 59 OF ___ PAGES

RIVERWALL GATE MONOLITH #20



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY @ RIVER WALL	PROJECT L. & D #1
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RIVERWALL GATE MONOLITH #20 (CONT'D)

AT ℄ MON

	LOADS IN KIPS	VERT. ↓	VERT. ↑	HORIZ. →	HORIZ. ←	ARM	MOM ↻ YY	MOM ↺ YY
C1		5746				4.0		22,984
C2		958				10.7	10,220	
C3	4×9×28×.087	88				11.5		1.000
C4			196			4.0	784	
C5			260			14.0	3650	
GATE		230				28.5		6,560
	Σ	7022^k	456^k			Σ	14,654	30,544

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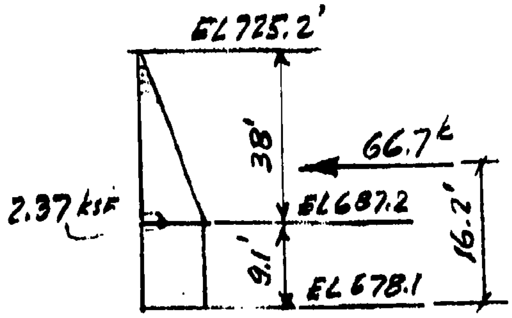
RIVER WALL GATE MONOLITH #20 (CONT'D)

	LOAD IN KIPS	V ↓	V ↑	ARM	MOMENT M_{xx} ↶	MOMENT M_{xx} ↷
	$C_1 + C_2 + C_3$	6792		0		
C_4			196	0		
C_5			260	7.0		1820
	GATE	230		5.56	1280	
		Σ 7022	456			
W_1	.73 × 32.0 × 14.0		327	7.0		2290
W_2	1.19* × 32 × 14.0 × ½		267	7.0		1870
						Σ 5980 ↷ 'k
W_3			327	7.0	2290	
	*LOCKSIDE AVERAGE			Σ	3570 ↶ 'k	
W_2'	2.37** × 32 × 14.0 × ½		532	7.0		3730
	**LOCKSIDE MAXIMUM	Σ 7022 k ↓	Σ 1642 k ↑	Σ	3570 'k	Σ 7840 'k ↷

RIVERWALL GATE MONOLITH #20 (CONT'D)

HYDROSTATIC LOAD ON GATES



$2.37 \times 38.0/2 = 45.10^k$

$2.37 \times 9.1 = \underline{21.60}$

66.70^k

$45.1 \times 21.77 = 980.0$

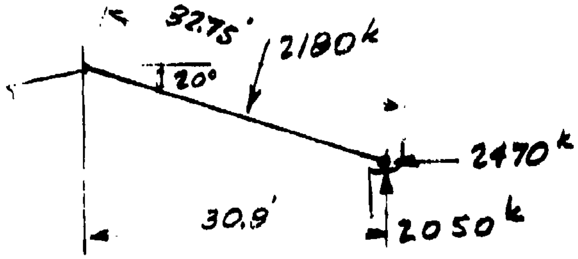
$\underline{21.6 \times 4.55} = \underline{98.3}$

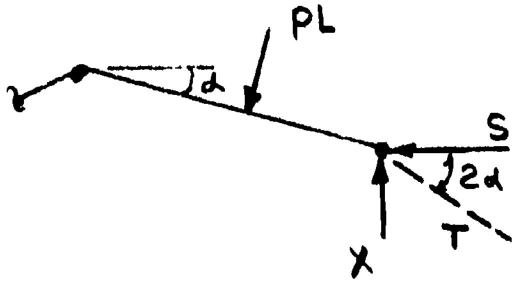
$66.7^k \qquad 1078.3^{\prime k}$

$y = \frac{1078.3}{66.7} = 16.2' / EL\ 694.3'$

TOTAL GATE THRUST

$66.7 \times 32.75 = 2180^k$





$T = \frac{PL}{2 \sin\alpha}$

$S = T \cos 2\alpha$

$X = T \sin 2\alpha$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY RIVER WALL	PROJECT L&D #1
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RIVERWALL GATE MONOLITH #20 (CONT'D)

$$\Sigma M_{xx} = \overset{4700}{5980} - 3570 + 2050 \times (\overset{18.7}{16.2+2.5}) = \overset{38400}{40820}^{\prime k}$$

$$\Sigma M_{yy} = 30544 - 14654 - 2470 \times 18.7 -$$

LOCKSIDE AVERAGE

$$- 32 \times 28.0/_2 \times 1.19/_2 \times (16.0 - 10.67)$$

$$- 3.10 \times \overset{1075}{24.8} \times 14 \times 16.55 + 460 + 190$$

$$+ .117 \times 11.6 \times 28 \times 5.8 + .117/_2 \times 11.6 \times 28 \times 5.8$$

$$\Sigma M_{yy} = 30544 - 14654 - 46200 - 1420 - 17800 + 650$$

$$+ 221 + \underset{80}{110} = 31525 - 47774 = -\underset{16,300}{16250}^{\prime k}$$

LOCKSIDE AVERAGE UPLIFT

$$\begin{cases} \Sigma M_{xx} = 40.820^{\prime k} & e_y = \underline{7.25'} \\ \Sigma M_{yy} = 48550^{\prime k} & e_x = \underline{8.62'} \end{cases}$$

$$\Sigma V = 7022 - 456 - 2 \times 327 - 267 = \underline{5645}^{k}$$

$$\Sigma H_x = \underline{3260}^{k}$$

$$\Sigma H_y = \underline{2050}^{k}$$

$$\Sigma H_R = 3850^{k}$$

(CONT'D ON PAGE 65)

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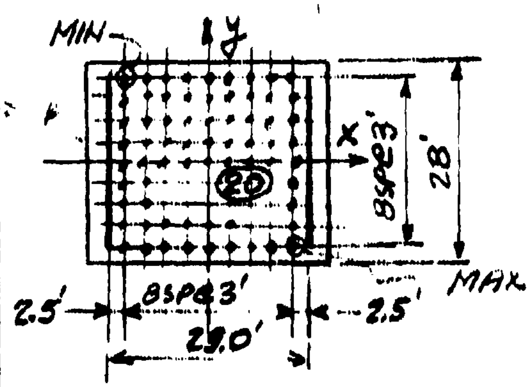
RIVERWALL GATE MONOLITH #20 (CONT'ED)

PILE LOADING FOR LOCKSIDE AVERAGE UPLIFT PRESSURE



$I_{yy} = 8690$

$S_{yy} = 600.0$

ANOTHER COMPUTATION FOR PILE LOADS IS ON PAGE 64 b, WHERE SHEET PILING IS NOT INCLUDED

$$I_{xx} = 22 \times 3.0^2 = 198$$
$$22 \times 6.0^2 = 792$$
$$22 \times 9.0^2 = 1783$$
$$22 \times 12.0^2 = 3170$$
$$5943$$

$$S_{xx} = \frac{5943}{12} = 495$$

$$P = \frac{5645}{99} \pm \frac{\overset{M_{yx}}{40820}}{495} \pm \frac{\overset{M_{xy}}{48550}}{600} = 57.0 \pm 82.5 \pm 81.0$$

MAX $P = 57.0 + 82.5 + 81.0 = \underline{220.5^k}$

MIN $P = \underline{-106.5^k}$ (UPLIFT)

TOTAL $H_x = 3260^k$ OR $\frac{3260}{99} = 33.0^k$/PILE

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING ~~IMPROVED~~ CONDITIONS OF STABILITY @ RIVER WALL COMPUTED M.T. CHECKED R.N.M.	PROJECT L&D #1 FILE NO. 800A DATE 1.75 PAGE 64G OF PAGES

River Wall Gate Monolith #20 (Cont'd)

Existing Conditions - Area Loading (Lockside Maximum)

$\Sigma V = \underline{5380^k}$

$\Sigma M_{xx} = 40820 + 1870 = \underline{42690}^{\prime k}$

$\Sigma M_{yy} = 48550 + 1420 = \underline{49970}^{\prime k}$

$\Sigma H_x = \underline{3260^k}$

$\Sigma H_y = \underline{2050^k}$ $\quad\quad \Sigma H_R = 3851^k$

$A = 912\ FT^2 \quad 29 \times 28$

$e_y = \dfrac{42690}{5380} = \underline{7.95} \quad\quad e_x = \dfrac{49970}{5380} = \underline{9.29}$

$e_y/b = 7.95/28.0 = .284; \quad e_x/l = 3.29/29.0 = .113$

$K = 9.7$

PILE LOADS ON PAGE 64C

1. $f_{SOIL} = 9.7 \times \dfrac{5380}{912} = 64.2\ KSF$

2. K OUTSIDE KERN

3. $\dfrac{\Sigma H}{\Sigma V} = \dfrac{3260}{5380} = 0.61$

4. $FSS_x = \dfrac{5380 \times .55}{3260} = 0.90 \quad\quad FSS_R = \dfrac{5380 \times .55}{3851} = .77$

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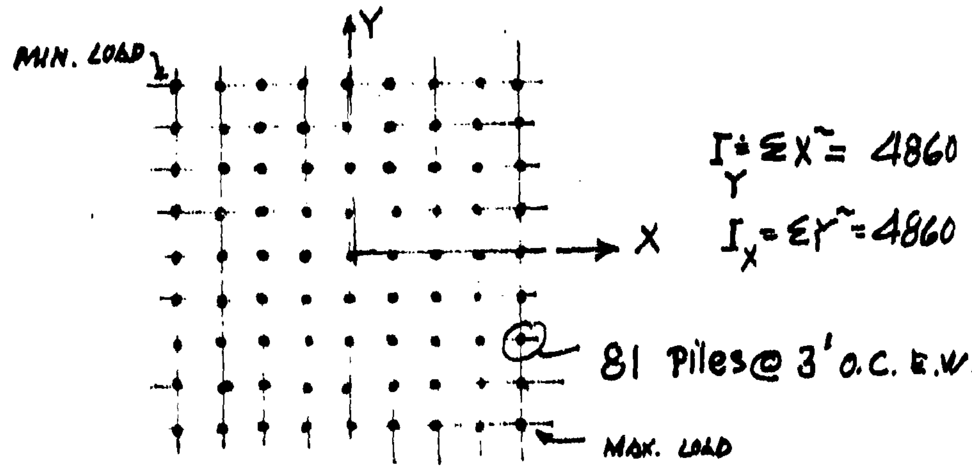
RIVER WALL GATE MONOLITH No 20
EXISTING, NORMAL LOADING CONDITION



$I_Y = \Sigma X^2 = 4860$

$I_X = \Sigma Y^2 = 4860$

ASSUME PILE FOUNDATION SUPPORTING ALL LOAD

"LOCK SIDE AVERAGE" Page 64

$\Sigma V = 5645^k \quad \Sigma M_X = 40,820'^k \quad \Sigma H_X = 3260^k$

$\Sigma M_Y = 48,550'^k$

$$P_{MAX.} = \frac{5645}{81} + \left\{ \frac{48550 \times 12}{4860} + \frac{40820 \times 12}{4860} \right\} = 69.7 + 119.9 + 100.8 = \underline{290.4}^k$$

$$P_{MIN.} = 69.7 - 119.9 - 100.8 = \underline{-151}^k$$

$$P_H = \frac{3260}{81} = \underline{40}^k$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY PILE LOAD	PROJECT L & D #1
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RIVER WALL GATE MONOLITH #20

EXISTING, NORMAL LOADING CONDITION

"LOCKSIDE MAXIMUM" (REF. p. 64a)

$\Sigma V = 5380^k$

$\Sigma M_{xx} = 42690^{'k}$ $\Sigma M_{yy} = 49970^{'k}$

$\Sigma H_x = 3260^k$ $\Sigma H_y = 2050^k$ $\Sigma H_R = 3851^k$

$$P_V = \frac{5380}{81} \pm \frac{42690 \times 12.0}{4860} \pm \frac{49970 \times 12.0}{4860} =$$

$$= 56 \pm 105 \pm 123 = \begin{cases} 284^k & \text{max} \\ -162^k & \text{min} \end{cases}$$

$P_{Hx} = \frac{3260}{81} = 40^{k/\text{pile}}$ $P_{HR} = \frac{3851}{81} = 48^{k/\text{pile}}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITIONS OF STABILITY @ RIVER WALL	PROJECT L&D #1
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RIVERWALL GATE MONOLITH #20 (CONT'D)

CHECK SOIL PRESSURE, ASSUMING AREA LOADING (LOCKSIDE AVERAGE)

$A = 29 \times 28 = 812\ FT^2$

$e_y = \frac{40820}{5645} = 7.25'$

$e_x = \frac{48550}{5645} = 8.62'$

$\frac{e_y}{b} = \frac{7.25}{28.0} = 0.26$

$\frac{e_x}{b} = \frac{8.62}{29.0} = 0.30$

$K = 7.70$

SUMMARY OF RESULTS

1). $f_{MAX} = 7.70 \times \frac{5645}{812} = 53.5\ KSF$

2). RESULTANT OUTSIDE KERN

3). $\frac{\Sigma H}{\Sigma V} = \frac{3260}{5645} = .58$

4. $FSS_{..} = \frac{5645 \times .55}{3260} = 0.95 \qquad FSS_R = \frac{5645 \times .55}{3850} = .81$

(FROM PAGE 63)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT SLIDING STABILITY	PROJECT L&D #1
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SLIDING STABILITY

TOP OF IMPERVIOUS LAYER (UNIT B) EL 660.00

H.WL EL 725.2' $\quad .0625 \times 65.2 = 4.08$ ksf

$\overrightarrow{H_{W_1}} = .0625 \times 65.2^2/2 = 133.0^k$

$\overleftarrow{H_{W_2}} = .0625 \times 70.2^2/2 = 154.0^k$ (TOP OF IMPERVIOUS LAYER @ EL 655.0)

TOTAL VERTICAL LOAD

$\Sigma V' = 6448 - 200 - 1139 = 5059^k$

$5059/28 = 180^k$/FT OF WIDTH

WEIGHT OF SOIL

$$\left.\begin{array}{ll} 4 \times 23 \times .068 & = 6.3 \\ 11.6 \times 32.0 \times .068 & = 25.2 \end{array}\right\} 31.5^k$$ (BETWEEN EL 675.6 & 660.0)

$9.5 \times 32.0 \times .115 = 35.0$ (BETWEEN EL 660.0 & 650.5')

$\Sigma V = 180.0 + 31.5 + 35.0 = 246.5^k$

$\phi = 22^\circ \quad \tan\phi = .404$

$246.5 \times .404 = 100.0^k$

$\phi = 18^\circ \quad \tan\phi = .325 \quad .325 \times 246.5 = 80.5^k$

$\phi = 23^\circ \quad \tan\phi = .424$

$246.5 \times .424 = 104.5^k$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT SLIDING STABILITY	PROJECT LGD #1
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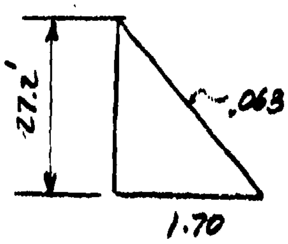
SLIDING STABILITY (CONT'ED)

$K_p = 1.5$

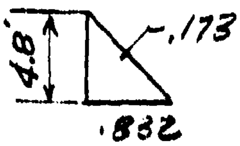
$1.5 \times .13 = .195\ ksf/1$

$1.5 \times .068 = .102\ ksf/1$

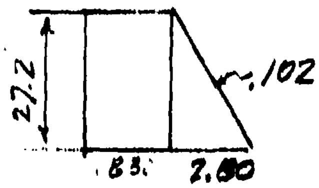
$1.5 \times .115 = .173\ ksf/1$



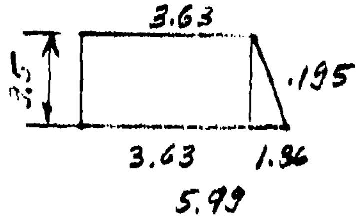
$0.85 \times 27.2 = 23.1^k$



$0.5 \times .173 \times 4.8^2 = 2.0^k$

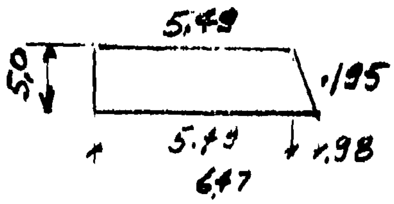


$\overset{22.6}{.832 \times 27.2} + \overset{38.2}{1.40 \times 27.2} = 60.8^k$



$\overset{34.2}{9.5 \times 3.63} + \overset{8.9}{.93 \times 9.5} = 43.1^k$

$\overleftarrow{\Sigma H} = 2.0 + 23.1 + 60.8 + 43.1 = 129.0^k$



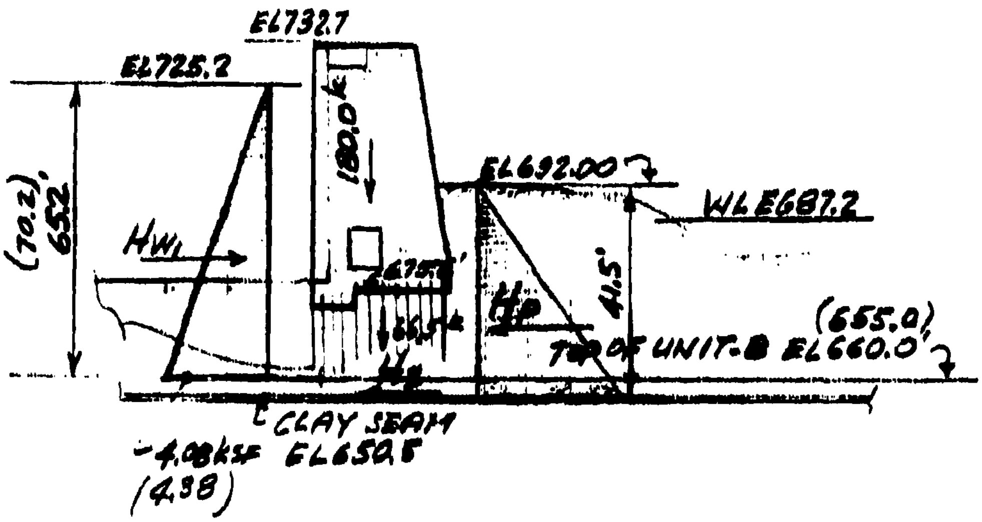
$\overset{27.4}{5.49 \times 5.0} + 2.5 \times .98 = 29.9^k$

$\overleftarrow{\Sigma H} = 129 + 30 = 159^k$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT SLIDING STABILITY OF L & D STRUCTURE COMPUTED M. J. CHECKED R.N.M.	PROJECT L & D #1 FILE NO. 800A DATE 1.75 PAGE 68 OF ___ PAGES

SLIDING STABILITY (CONT'ED)

SLIDING STABILITY @ CLAY SEAM - SUMMARY



ASSUME NO COHESION IN CLAY SEAM

$H_{W1} = 4.08 \times 65.2/2 = 133.0^k \quad (154^k)$

$H_S = 246.5 \times .404 = 100.0^k \quad (104.5^k)$

$H_P = 129.0^k$

$FSS = \frac{100.0+129}{133.0} = 1.72 \qquad \phi = 22° \qquad \frac{100+159}{154} = 1.68$

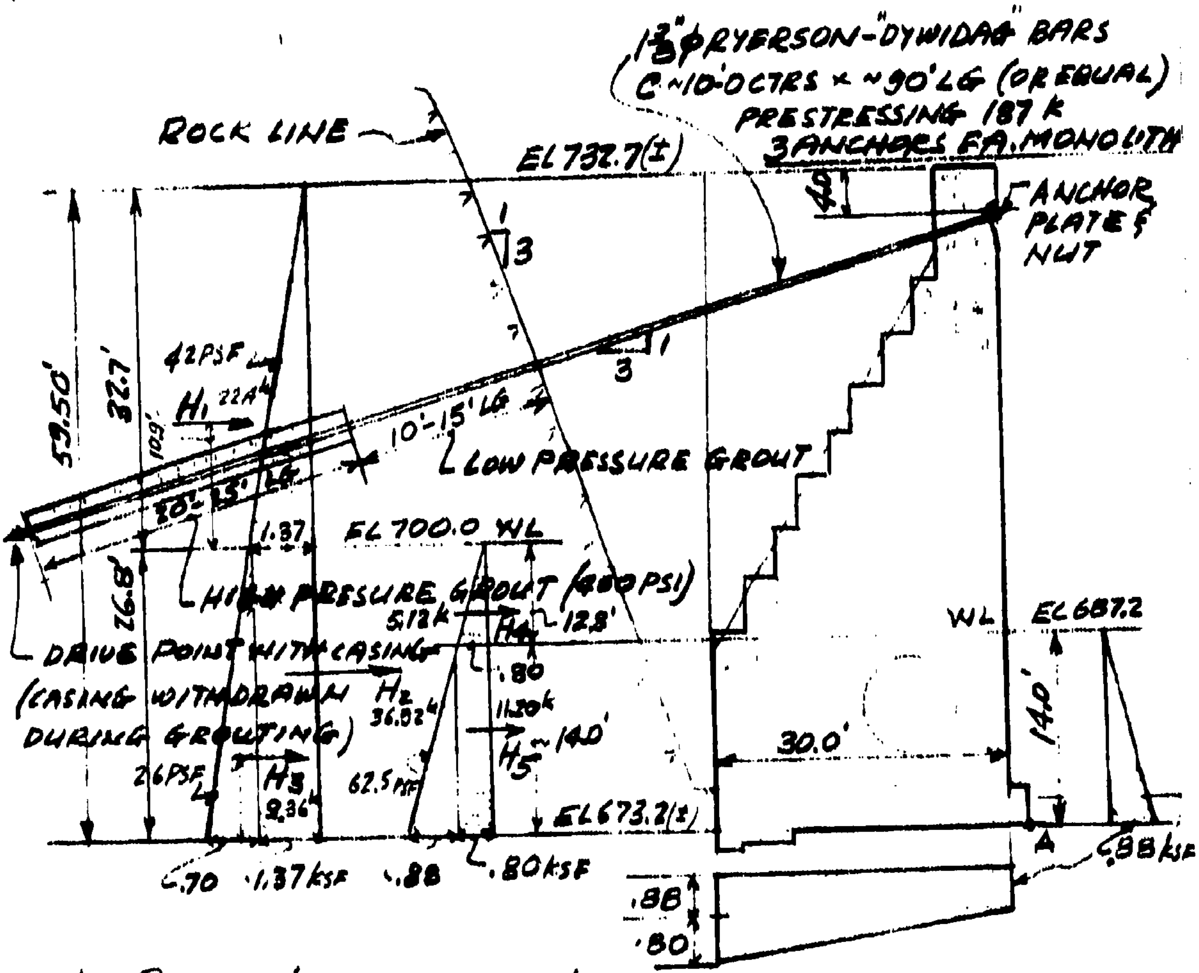
$FSS = \frac{104.5+129}{133} = 1.75 \qquad \phi = 23° \qquad \frac{104.5+159}{154} = 1.70$

$FSS = \frac{80.5+129}{1.33} = 1.58 \qquad \phi = 18° \qquad \frac{80.5+129}{154} = 1.36$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT LED #1
	COMPUTED M. J. CHECKED R. N. M.	FILE NO 800A
		DATE 11.74 PAGE 69 OF ___ PAGES

LANDWALL MONOLITHS ~~#4~~ 5-15 - STABILIZING BY ANCHORS



1). $R = 219.0^k$ INSIDE MIDDLE $\frac{1}{3}$

2). $\frac{\Sigma H}{\Sigma V} = \frac{71.0}{207.0} = 0.343$

3). $f_{SOIL} = 6.5 \pm 5.2 \begin{cases} MAX & 11.7\ ksf \\ MIN & 1.3\ ksf \end{cases}$

4). $FSS = \frac{207 \times .625}{70.0} = 1.85$

5). $FSOT = \frac{4831}{2404} = 2.0$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT LED #1
		FILE No 800A
	COMPUTED M.J. CHECKED R.N.M.	DATE 11.74 PAGE 70 OF ___ PAGES

LANDWALL MONOLITHS #5-15-STABILIZING BY ANCHORS (CONT)

$H_1 = 1.37 \times 32.7/2 = 22.40^k$

$H_2 = 1.37 \times 26.8 = 36.92$

$H_3 = .70 \times 26.8/2 = 9.36$

$H_4 = .80 \times 12.8/2 = 5.12$

$H_5 = .80 \times 14.0 = 11.20^k$

$\Sigma H = 85.0^k$

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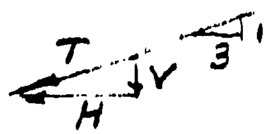
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT LED #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO. 800A
		DATE 11.74 PAGE 71 OF ___ PAGES

LANDWALL MONOLITHS #~~4~~5-15 STABILIZING BY ANCHORS (CONT'ED)

MAXIMUM LOAD ON ANCHORS (ACTIVE PRESS. CONDITION)

22.40	× 37.7	=	846.0
36.92	× 13.4	=	495.0
9.36	× 8.93	=	83.6
5.12	× 18.27	=	93.4
11.20	× 7.00	=	78.4
$\Sigma 85.0^k$			$\Sigma 1596.4$ $^{1k}/_{1}$ (MA)

$H = \frac{1596.4}{55.50} = 28.7\ ^k/$FT. OF WALL



$T = \frac{28.7}{3} \times 3.16 = 30.0\ ^k/_1$ $V = 9.5\ ^k/_1$

TOTAL ΣT, ON 30' MONOLITH = 900.0^k

USE $1\frac{3}{8}$" RYERSON "DYWIDAG" BARS, WITH PRESTRESSING

$.80 T_u = 187.2^k$

CHECK STABILITY CONDITIONS USING 3 ANCHORS FOR EACH MONOLITH, SEE NEXT SHT. [3 × 187.2 < 900.0^k OK.]

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT L&D #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO 800A
		DATE 11.74 PAGE 72 OF ___ PAGES

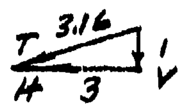
LANDWALL MONOLITHS #~~4~~ 5-15 · STABILIZING BY ANCHORS (CONT'D)

$1\frac{3}{8}\phi$ BARS; $.80\,T_u = 187.2^k$ ("RYERSON" CATALOG 40-1 PG. #5)

LOSS OF PRESTRESS ASSUMED 25 KSI (ACI, 318-71 COMMENT. 18.6.1)

USABLE TENSION $187.2 - \overset{39.0}{1.56 \times 25.0} = 148.2$ k/BAR

$$\frac{3 \times 148.2}{30} \times \frac{3.0}{3.16} = 14.0^k/FT \ (= H)$$



EXISTING CONDITIONS

$\Sigma V = 202.0^k \quad \Sigma H = 85.0^k \quad \Sigma M_A = 1647.0^{\prime k}$

IMPROVED CONDITIONS

$\Sigma V = 202.0 + 5.0 = 207.0^k$

$\Sigma H = 85.0 - 14.0 = \overrightarrow{71.0}^k$

$\Sigma M_A = 1647.0 + 14.0 \times 55.5 = 2425^{\prime k}$

$\Sigma R = 219.0^k$

$a = \frac{2425}{207} = \underline{11.7'}$

$e = 16.0 - 11.7 = \underline{4.3'}$

$M_{yy} = 4.3 \times 207 = 890.0^{\prime k}$ $\qquad 1596.4 + 808 = 2404^{\prime k}$

$S_{yy} = \frac{37.0^2}{6} = 170.0\ FT^3$ $\qquad 4051 + 14 \times 55.5 = 4831^{\prime k}$

FOR RESULTS OF IMPROVED CONDITIONS SEE SHT. #1

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILIZATION BY ROCK ANCHORS $1\frac{3}{8}$" φ COMPUTED R.N.M. CHECKED JJ	PROJECT Lock & Dam # 1 FILE NO 900 A DATE Jan '75 PAGE 72a OF PAGES

LANDWALS 5-15

ANALYSIS OF UPPER LANDWALL MONOLITHS FOR ASSUMED WATER SURFACE ON LANDWARD SIDE AT ELEVATION 704

Ref.: pages 69-72, and 75a

* P_r = Friction resistance due to weight of submerged slab = 5^k (Pg. 10)

	ΣForces for W.S @ El. 700 (From pg 72)	Change in hydrostatic and earth pressures, (Pg 75a)	ΣForces for W.S @ El 704
$\Sigma H \rightarrow +$	$+71^k - P_r$*	6^k	$77 - 5 = 72^k$
$\Sigma V \downarrow +$	$+201^k$	-4^k	203^k
ΣM_A +	$-2425'^k$	$163'^k$	$2262'^k$

$a = \frac{2262}{203} = 11.14'$ $e = 4.86' < 5.33$

(1) Resultant, R = 203 inside middle $\frac{L}{3}$ by 0.47'

(2) $f_{soil} = \frac{203}{32}\left(1 + \frac{6 \times 4.86}{32}\right) = 6.34\,(1 \pm 0.91)$

$f_{max} = \underline{12.1}$ KSF

$f_{min} = 0.6$ KSF

(3) Factor of sliding $= \frac{72}{203} = 0.355$ $\frac{\Sigma H}{\Sigma V}$

(4) Factor of safety against sliding, FS = 1.76

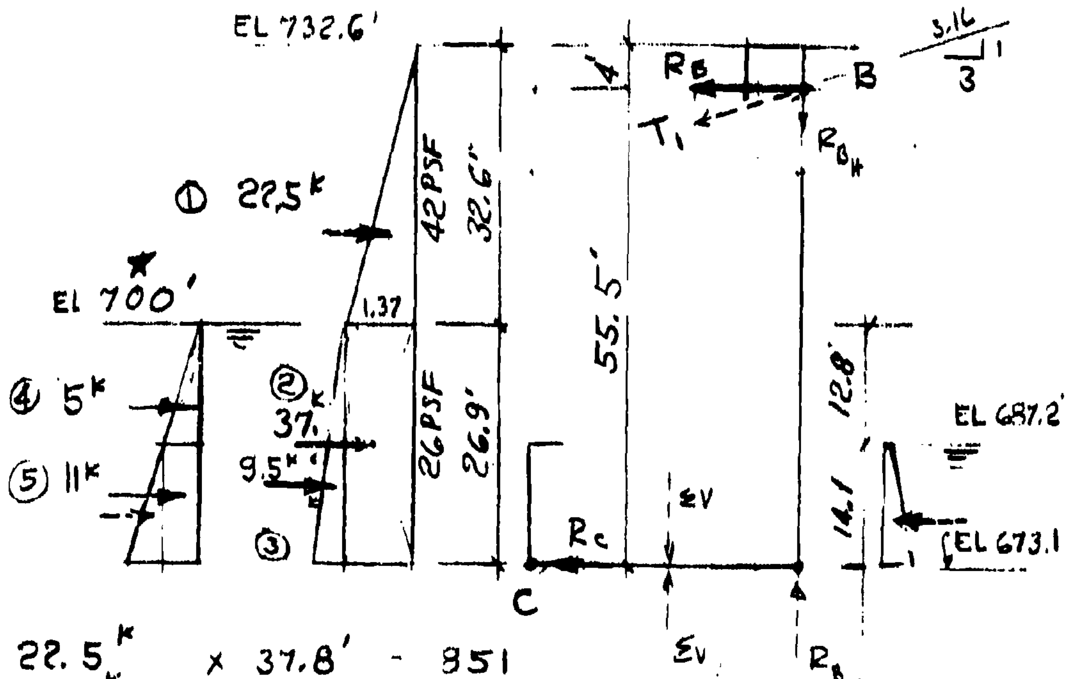
(5) Factor of safety against overturning

$F.S.O.T. = \frac{4051}{2487 - 14.0 \times 55.5} = 2.37$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILIZATION USING LARGER ROCK ANCHORS	PROJECT LOCK & DAM NO. 1
	COMPUTED R.H.M. CHECKED JI	FILE NO. 800 A
		DATE 2/'75 PAGE 72 b OF ___ PAGES

LANDWALL MONOLITHS 5-15, IMPROVEMENT OF STABILITY, USING LARGER ANCHORS
(ITEM 19 OF GENERAL COMMENTS RECEIVED 2/21/75)

DETERMINATION OF MAXIMUM SIZE OF ROCK ANCHORS IN LANDWALL, UTILIZING ONLY ACTIVE SOIL PRESSURE IN BACKFILL DURING PRESTRESSING.



①	22.5^K	× 37.8'	851
②	37.0^K	13.5'	500
③	9.5^K	9.0'	86
④	5.0^K	18.4'	92
⑤	11.0^K	4.7'	52
	85^K	$55.5\,R_B$ =	1581

$R_B = \underline{28.5^K}$

$R_C = \underline{56.5^K}$

$T_1 = 28.5 \times \frac{3.16}{3.0} = 30^K$ PER FOOT OF WALL

$T = 30.0 \times 15 = \underline{450^K}$ MAX FOR ROCK ANCHORS SPCD 15' O.C.

★ ASSUMED W.S. ELEV. DURING PRESTRESSING

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILIZATION USING LARGER ROCK ANCHORS COMPUTED R.H.M. CHECKED JJ	PROJECT LOCK & DAM NO. 1 FILE NO. 800 A DATE 2/'75 PAGE 72C OF ___ PAGES

LANDWALL MONOLITHS #15-15
IMPROVEMENT OF STABILITY BY LARGER ANCHORS (CONT'D)

MAX PRESTRESSING FORCE FOR ACTIVE SOIL PRESSURE ONLY

ASSUME 2-$1\frac{1}{4}''\phi$ BARS/ANCH.-See sketch attached. "RYERSON"

PRESTRESSING FORCE, $0.80\, f_{pu}$ = 150 per rod

$\times 2$

300^K

LOSSES $1.25^{\square''} \times 2 \times 25^{ksi}$ = -63

DESIGN CAPACITY PER ANCHOR = $\underline{\underline{237}}^K$

ASSUME 3-$1\frac{1}{4}''\phi$ RODS PER ANCHOR $150 \times 3 = 450^K$

DESIGN CAPACITY/ANCHOR = $237 \times \frac{3}{2}$ = $\underline{\underline{356}}^K$

2-$1\frac{1}{4}''\phi$ (DOUBLE ROD) CAPACITY = $\frac{237}{15} = 15.8^K/ft.,\ < 30,^*$

3-$1\frac{1}{4}''\phi$ (TRIPLE ROD) CAPACITY = $\frac{356}{15} = 23.7^K/ft.,\ < 30,^*$

DOUBLE ROD ANCHOR:

$15.8 \times \frac{3.0}{3.16} = \underline{\underline{15}}^K \leftarrow$

$15.8 \times \frac{1}{3.16} = 5.0^K \downarrow$

TRIPLE ROD ANCHOR:

$\frac{23.7 \times 3.0}{3.16} = 22.5^K \leftarrow$ PER FOOT OF WALL

$\frac{23.7 \times 1}{3.16} = \underline{\underline{7.5}}^K \downarrow$

* TENSION DUE TO MAXIMUM ACTIVE SOIL PRESSURE

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILIZATION USING LARGER ROCK ANCHORS COMPUTED R.N.M. CHECKED JI	PROJECT LOCK & DAM NO. 1 FILE No. 800A DATE 2/'75 PAGE 72d OF ___ PAGES

LANDWALL MONOLITHS 5-15 IMPROVEMENT OF STABILITY USING LARGER ANCHORS

STABILITY ANALYSIS (refer to page 72a)

A. 2 - $1\frac{1}{4}$" Ø STRAND PER ANCHOR, 2 ANCHORS PER MONOLITH

$\Sigma H = 85 - 15 \text{ ----- } = 70^{K} \rightarrow$

$\Sigma V = 207 + 5 \text{ ----- } = 212 \downarrow$

$\Sigma M = 1647 + 55.5 \times 15.0 = 2480'^{K}$

$L = 32'$

$\frac{L}{6} = 5.3'$

$\frac{L}{4} = 8.0'$

(1) $\bar{X} = \frac{2480}{212} = 11.7' \quad e = 4.3$

RESULTANT INSIDE MIDDLE $\frac{1}{3}$, 1.0

(2) $f = \frac{212}{32}\left(1 \pm \frac{6 \times 4.3}{32}\right) = \begin{cases} 12.0 \text{ KSF MAX.} \\ 1.3 \text{ KSF (MIN)} \end{cases}$

(3) $\frac{\Sigma H}{\Sigma V} = 0.33$ (4) FSS = 1.89

(5) $F.S.O.T. = \frac{4051}{2487 - 15.0 \times 55.5} = 2.45$

B. 3 - $1\frac{1}{4}$" Ø STRANDS PER ANCHOR, 2 ANCHORS PER MONOLITH

$\Sigma H = 85 - 22.5 = 62.5^{k}$

$\Sigma V = 207 + 7.5 = 214.5^{k}$

$\Sigma M_A = 1647 + 55.5(22.5) = 2896'^{k}$

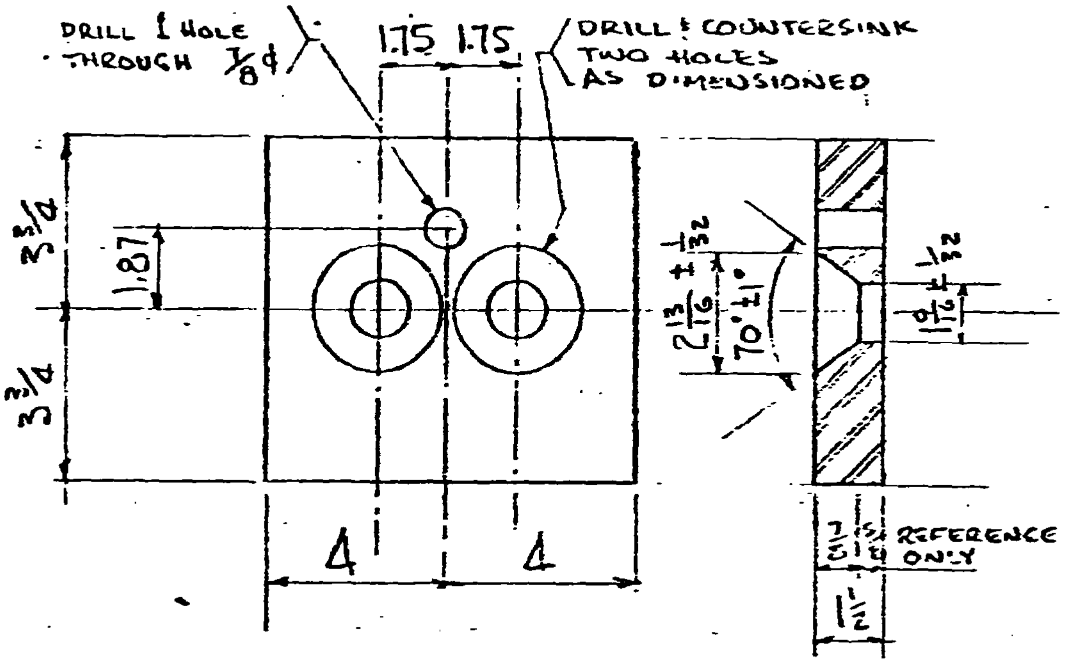
(1) $\bar{X} = 13.5 \quad e = 16.0 - 13.5 = 2.5'$

RESULTANT INSIDE MIDDLE 1/3 BY 2.83

(2) $f = \frac{214.5}{32}\left(1 \pm \frac{6 \times 2.5}{32}\right) = \begin{cases} 9.80 \text{ KSF MAX.} \\ 3.60 \text{ KSF MIN.} \end{cases}$

(3) $\frac{\Sigma H}{\Sigma V} = 0.29$ (4) FSS = 2.16

(5) $F.S.O.T. = \frac{4051}{2487 - 22.5 \times 55.5} = 3.27$



MATERIAL

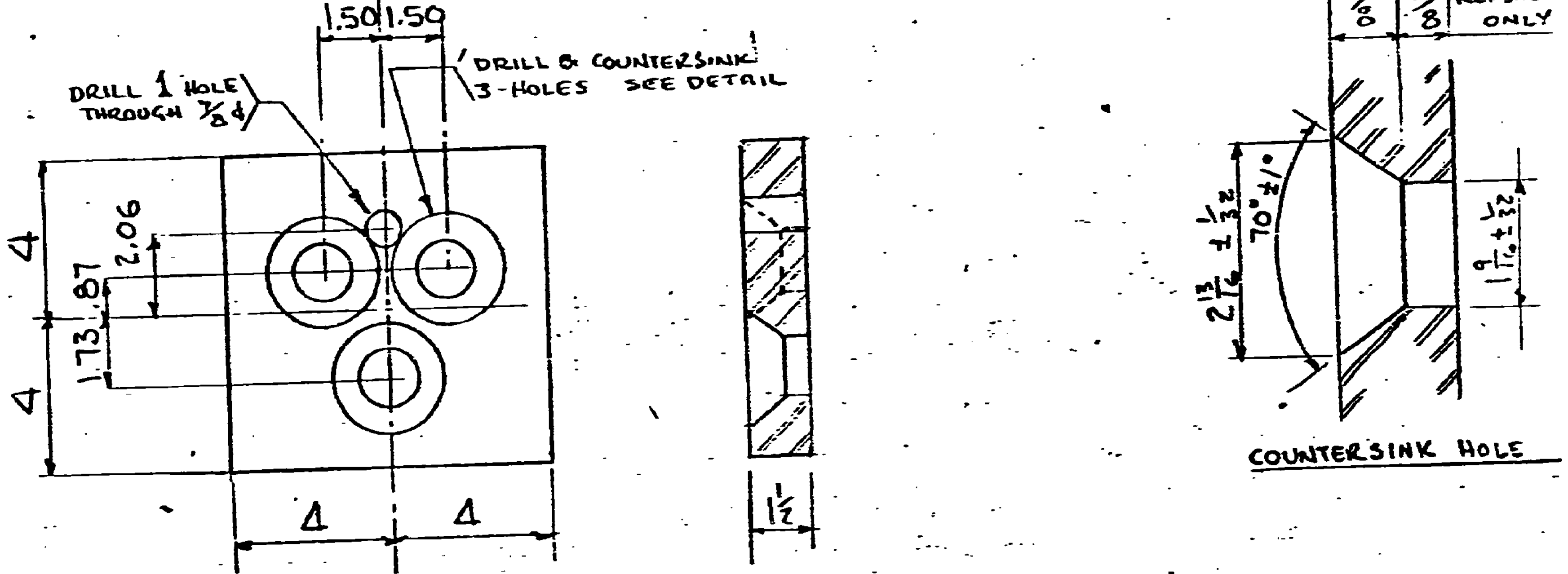
1 PL 1½ x 7½ x 8 A36

OR F_y min = 33000, CARBON

FOR REFERENCE ONLY.

TOP PLATE FOR TWO BARS - TRUMAN DAM	DRAWN BY CLYDE	DATE 10-
CONSTRUCTION PRODUCTS COMPANY	REVISED BY	DATE
	APPROVED BY G che dla	DATE 10-

Page 72 F



COUNTERSINK HOLE

MATERIAL

1 PL 1 1/2 x 8 x 8 A36
OR MIN F_y = 33000, MIN CARBON = .15

FOR REFERENCE ONLY.

TOP PLATE FOR THREE BARS TRUMAN DAM

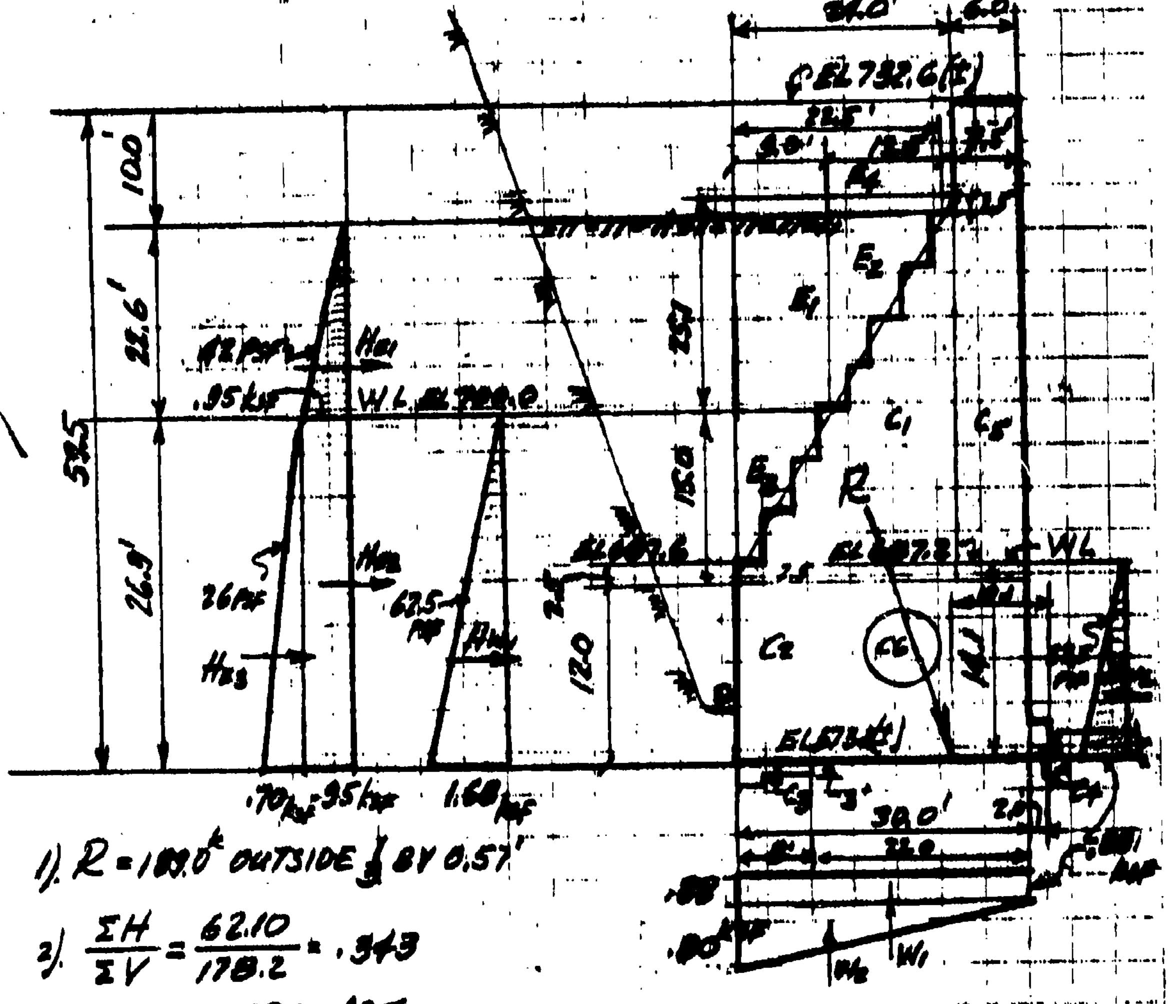
CONSTRUCTION PRODUCTS COMPANY

DRAWN BY	DATE
CLYDE	10-3-74
REVISED BY	DATE
APPROVED BY G. Chadha	DATE 10-7-74

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS COMPUTED M.J. CHECKED R.V.M.	PROJECT LED #1 FILE No. 800A DATE 8.74 PAGE 73 OF ___ PAGES

LANDWALL MONOLITHS 5-15 - LOWERING BACKFILL BY 10'-0



1). $R = 180.0^k$ OUTSIDE $\frac{1}{3}$ BY 0.57'

2). $\frac{\Sigma H}{\Sigma V} = \frac{62.10}{178.2} = .343$

3). $FSS = \frac{178.2 \times .625}{62.10} = 1.79$

4). $f_{SOIL} = \frac{2}{3} \times 178.2/10.1 = 12.0 \, KSF$

5). $FSOT = \frac{3613.0}{1812.0} = 2.0$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF LAND WALL MONOLITHS	PROJECT L&D #1
	COMPUTED M.J. CHECKED R.N.M.	FILE NO. 800A
		DATE 8.74 PAGE 74 OF ___ PAGES

LANDWALL MONOLITHS # ~~4~~ 5 - 15 - LOWERING BACKFILL BY 10'-0

	LOADS IN KIPS	VERT. ↓	VERT ↑	HORIZ →	HORIZ. ←	ARM	MOM A ↻	MOM A ↺
C_1	40.0×24×½×.15	72.0				16.0		1150.0
C_2	12.0×30.0×.15	54.0				17.0		918.0
C_3	8.0×3.0×.088	2.1				28.0		58.8
C_4	2.0×4.0×.088	0.7				1.0		0.7
C_5	47.5×6.0×.150	42.8				5.0		214.0
C_6	π×4.75²×.088		6.2			15.0	94.0	
E_1	22.6×9.0×.110	22.4				27.5		617.0
E_2	16.0×22.6×.055	20.0				18.5		370.0
E_3	9.0×7.5×.130	8.8				29.0		255.0
								Σ3583.5
W_1	.88×30.0		26.4			17.0	450.0	
W_2	.40×30.0		12.0			22.0	264.0	
							Σ808.0	
H_{E1}	.95×11.3			10.7		34.4	370.0	
H_{E2}	.95×26.9			25.6		13.5	345.0	
H_{E3}	.35×26.9			9.4		9.0	84.6	
H_{W1}	.84×26.9			22.6		9.0	204.0	
H_{W2}	.44×14.1				6.2	4.7		29.2
		222.8	44.6	68.3	6.2		1812.0	3613.0

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF LANDWALL MONOLITHS #4-15	PROJECT LED #1
	COMPUTED M.J. CHECKED J.W.M.	FILE No. 800A
		DATE 8.74 PAGE 75 OF ___ PAGES

LANDWALL MONOLITHS #5-15 - LOWERING BACKFILL BY 10'0 (CONT'ED)

$\Sigma V = 222.8 - 44.60 = 178.2^k$

$\Sigma M = 3613 - 1812.0 = 1801^{'k}$

$\Sigma H = 62.1^k \qquad R = 189.0^k$

$a = \frac{18010}{181.2} = 10.10$

$e = \overset{(10.67)}{32.0/3} - 10.10 = 0.57$

1. RESULTANT OUTSIDE MIDDLE $\frac{1}{3}$ BY 0.57'

2. $\frac{\Sigma H}{\Sigma V} = \frac{62.10}{178.2} = .343$

3. $F.S.S. = \frac{178.2 \times .625}{62.1} = 1.79$

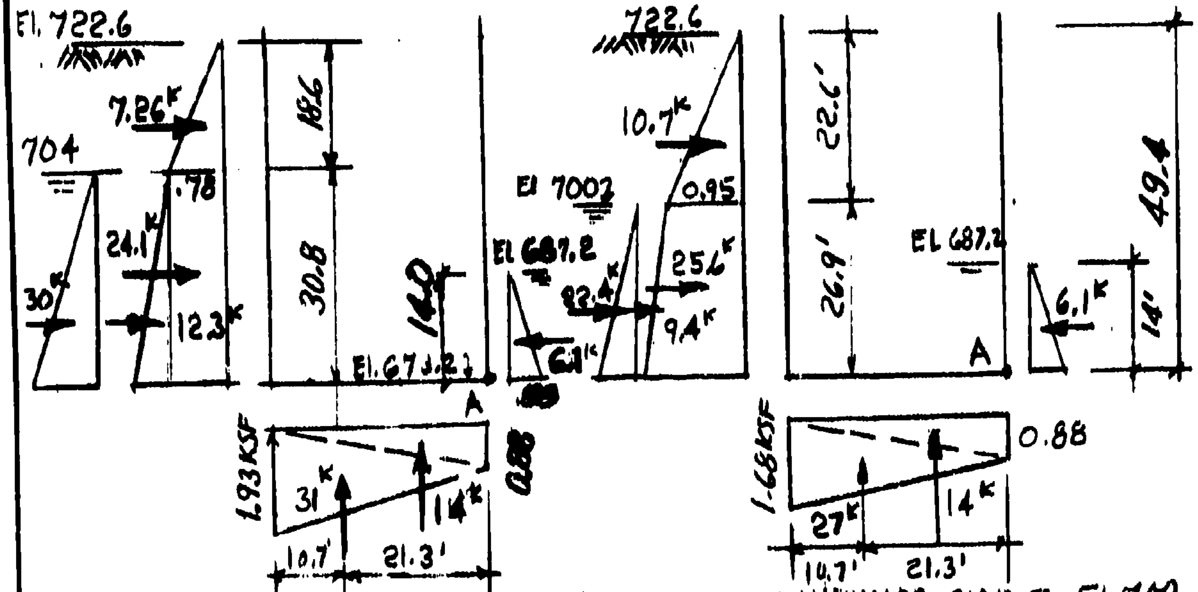
4. $f_{SOIL} = \frac{2}{3} \times 181.2 / 10.10 = 12.0$ ksf

5. $F.S.O.T. = \frac{3613.0}{1812} = 2.0$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL (MON 5-15) STABILIZATION BY LOWERING OF BACKFILL COMPUTED R.N.M. CHECKED JL	PROJECT LOCK & DAM NO. 1 FILE NO. 800 A DATE Jan '75 PAGE 75A OF ___ PAGES

ANALYSIS OF UPPER LANDWALL MONOLITHS FOR ASSUMED WATER SURFACE ON LANDWARD SIDE AT ELEVATION 704

Reference: Pgs 73 — 75 of this computation



W.S. LANDWARD SIDE @ EL 704 W.S. LANDWARD SIDE @ EL 700

$30 + 7.26 + 24.1 + 12.3 - 6.1 = 68^k \rightarrow$

$\times 10.3 \quad \times 37 \quad \times 15.4 \quad \times 10.3 \quad \times 4.7$

$309 + 269 + 371 + 127 - 29 = 1047'k$

$31 + 14 = 45^k \uparrow$

$\times 21.3 \quad \times 10.7$

$660 + 150 \cdot 810'k$

$22.4 + 10.7 + 25.6 + 9.4 - 6.1 = 62^k \rightarrow$

$\times 9. \quad \times 34.4 \quad \times 13.4 \quad \times 9 \quad \times 4.7$

$202 + 368 + 343 + 85 - 29 = 969'k$

$27 + 14 = 41^k \uparrow$

$\times 21.3 \quad \times 10.7$

$575 + 150 = 725'k$

$\Delta H = 68 - 62 = \underline{6^k} \rightarrow$

$\Delta V = 45 - 41 = \underline{4^k} \uparrow$

$\Delta M_A = 1047 + 810 - 969 - 725 = \underline{163}'k$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL STABILIZATION BY LOWERING OF BACKFILL COMPUTED R.N.M. CHECKED JL	PROJECT LOCK and DAM #1 FILE NO 800 A DATE JAN '75 PAGE 75b OF ___ PAGES

Upper Landwall Monoliths, (cont'd)

	Σ FORCES FOR W.S.@ El. 700	CHANGE IN HYDROSTATIC AND EARTH FORCES.	Σ FORCES FOR W.S.@ El. 704
ΣH → (+)	$+62^k - P_r$*	$+6^k$	$+68' - 5 = 63^k$
ΣV ↓ (+)	$+178^k$	-4^k	$+174^k$
ΣM_A ↻ (+)	$-1801'^k$	$+163'k$	$-1638'k$

$$d = \frac{1638}{174} = 9.41' \qquad e = 16 - 9.41 = 6.59$$

$$\frac{5.33}{1.26'}$$

Resultant $R = 174^k$, outside middle $\frac{1}{3}$, $\underline{1.26'}$

$$f_{soil} = \frac{2}{3} \times \frac{174}{9.41} = \underline{12.33} \text{ KSF}$$

$$\text{Factor of sliding} = \frac{\Sigma H}{\Sigma V} = 0.36$$

$$\text{Factor of safety against sliding} = \frac{.625}{.36} = \underline{1.74}$$

$$F.S.O.T. = \frac{3519}{1718 + 163} = 1.87$$

* Friction resistance due to weight of submerged slab.
$P_r = 56 \times 2 \times 0.082 \times 0.55 = 5^k$ ←

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LAND WALL - IMPROVED CONDITION COMPUTED RNM CHECKED JL	PROJECT LOCK & DAM NO. 1 FILE NO. 800 A DATE 3/'75 PAGE 75C OF ___ PAGES

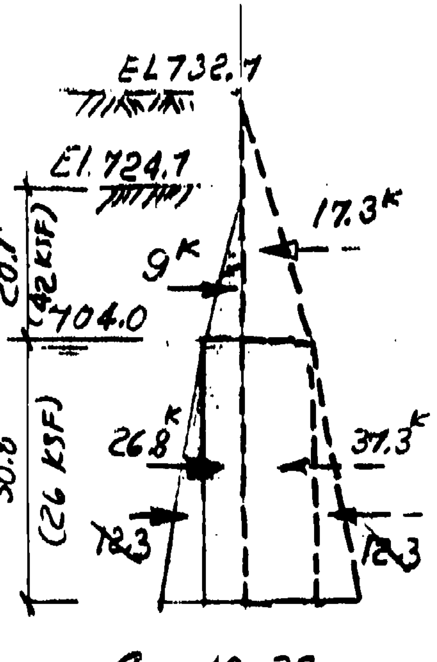
MONOLITH No 3
NORMAL LOADING
IMPROVED (OR STABILIZED) CONDITION

BACKFILL IS LOWERED BY 8', GATE SHAFTS ARE FILLED.

The only differences in load between this condition and that of existing (Lowered conduit, shafts filled) condition are the following decreases both in horizontal earth pressure, and weight of backfill

$\frac{20.1^2}{2}(.042) = 9.0^k$

$20.1(.042)(30.8) = 26.8^k$



$\Delta H = (17.3-9) + (37.3-26.8)$
$= 8.3 + 10.5 = \underline{18.8^k}$

$\Delta M_A = -(17.3)40.4 + 9(37.7)$
$+ (-)10.5 \times 15.4 - 5 \times 29$
$= (-699 + 339) - 162 + 145$
$= -377'^k$

$\Delta V = 8 \times 6 \times 0.11 = 5^k \uparrow$
$\times 29$
$145\ k$

$\Sigma H = 85 - 18.8 = 66.2^k \rightarrow$ $\quad a = 10.39$
$\Sigma V = 201 - 5. = 195^k \downarrow$ $\quad e\ 5.61 > 5.33$
$\Sigma M_A = 1660 + 377 = 2037$

(1) Resultant outside middle 1/3 by 0.28'
(2) $f_{soil} = \frac{2}{3}\left(\frac{195}{10.39}\right) = 12.5$ KSF
(3) $\Sigma H / \Sigma V = 66.2/195 = 0.338$ (4) $SSF = 1.85$
(4) FSOT not necessary, resultant is almost at middle 1/3 (=2.05

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LAND WALL - IMPROVED CONDITION COMPUTED R.N.M. CHECKED JI	PROJECT LOCK & DAM NO. 1 FILE No 800 A DATE 3/'75 PAGE 75d OF ___ PAGES

MONOLITH No 4
NORMAL LOADING
IMPROVED (OR STABILIZED) CONDITION

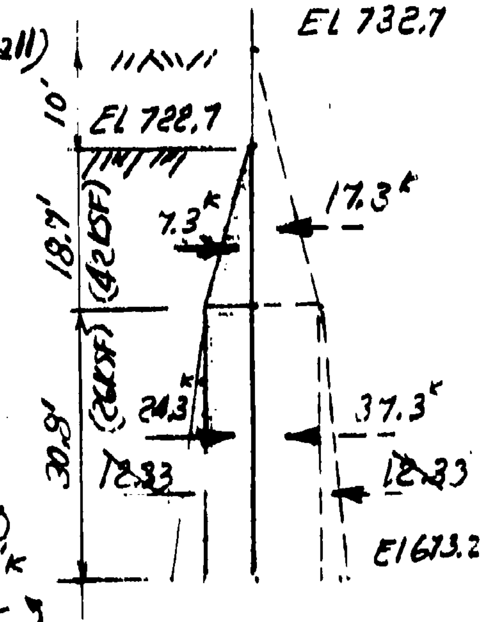
BACKFILL IS LOWERED BY 10 FEET - The onlly differences in load between this condition and that of existing (lowered conduit, 2 gate shafts full conc. sect.) condition are the following decreases (ΔH, ΔV & ΔM) both in horizontal earth pressure and weight of backfill.

$18.7^2(\frac{1}{2})(.042) = 7.3$ kips/(ft of wall)
$18.7(.042)(30.8) = 24.2$

$$\Delta H = \begin{array}{r} 17.3 \\ -\ 7.3 \\ \hline 10.0^k \end{array} + \begin{array}{r} 37.3 \\ -\ 24.3 \\ \hline 13.0^k \end{array} = -23.0^k \leftarrow$$

$$\Delta V = 10 \times 6 \times .11 = -6.6^k \uparrow$$

$-17.3 \times 40.4 + 7.3(37.03) = -429'^k$
$-13.0 \times 15.4 \ldots = -200'^k$
-629
$6.6 \times 29.0 \ldots = +191'^k$
$\Delta M_A = -438'^k$



$\Sigma H = 85.0 - 23.0 = 62.0^k \rightarrow$ $\quad a = 10.62'$
$\Sigma V = 191.0 - 6.6 = 184.4^k \downarrow$ $\quad e = 5.38'$
$\Sigma M_A = -1520 - 438 = -1958'^k$ $\quad -5.33 \ldots \frac{L}{6}$
$\quad 0.05$ feet

(1) Resultant outside middle $\frac{1}{3}$ by ---
(2) $f_{soil} = (2/3)(184.4)(1/10.6) = 11.58$ KSF
(3) $(\Sigma H/\Sigma V) = 0.338$ (4) S.S.F. = 1.86
(5) $\frac{4128-140-191}{2968-629} = \frac{3797}{1639} =$ [redacted] $= 2.06 =$ F.S.O.T.

LANDWALL GATE MONOLITH #17 - 10'-0 BACKFILL REMOVAL

$H_1 =$	$.95 \times 22.70/2 \times 28.6$	$= 309.0^k$	37.37	11,500
$H_2 =$	$.95 \times 29.80 \times 28.6$	$= 810.0$	14.90	12,030
$H_3 =$		$= 338.0$	9.93	3,350
$H_4 =$		$= 145.0$	21.27	3,100
$H_5 =$		$= 389.0$	8.50	3,310
		1991.0^k		$33,290'^k$

$V_3' = 6.0 \times 28.6 \times 10.0 \times .115 = 197.0^k \uparrow$

$\Sigma V = 5910 - 197 = 5713^k \downarrow$

$\Sigma H_x = 1991.0^k$

$\Sigma M_A = 108,304 - 197.0 \times 27.0 - 33,290 - 23460 = 46,234'^k$

$\Sigma M_{xx} = 1550'^k \quad \Sigma M_{yy} = 5289 \times 6.90 = 39,420'^k$

$a = \frac{46,234}{5713} = 8.10$

$e = 15.0 - 8.10 = 6.90 > 5.00$ OUTSIDE MIDDLE $\frac{1}{3}$ BY $\underline{1.90}$

MAX SOIL PRESSURE

$f = \frac{2}{3} \times \frac{5713}{28.6 \times 8.10} = 16.44$ ksf

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LANDWALL GATE MONOLITH #17-10'0 BACKFILL REMOVAL

(CONT'ED)

$\Sigma V = 5713.0^k$ $\Sigma H_x = 1991.0^k$ $\Sigma M_{yy} = 39400^{'k}$

1). $f_{SOIL} = 16.44$ KSF

2). $R = 6050^k$ outside middle 1/3 by 1.9' ~~INSIDE MIDDLE 1/2 BY ...~~

3). $\frac{\Sigma H}{\Sigma V} = \frac{1991}{5713} = .350$

4). $FSS = \frac{5713 \times .625}{1991.0} = 1.79$

5). $FSOT = \frac{102964}{56750} = 1.81$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT L&D #1
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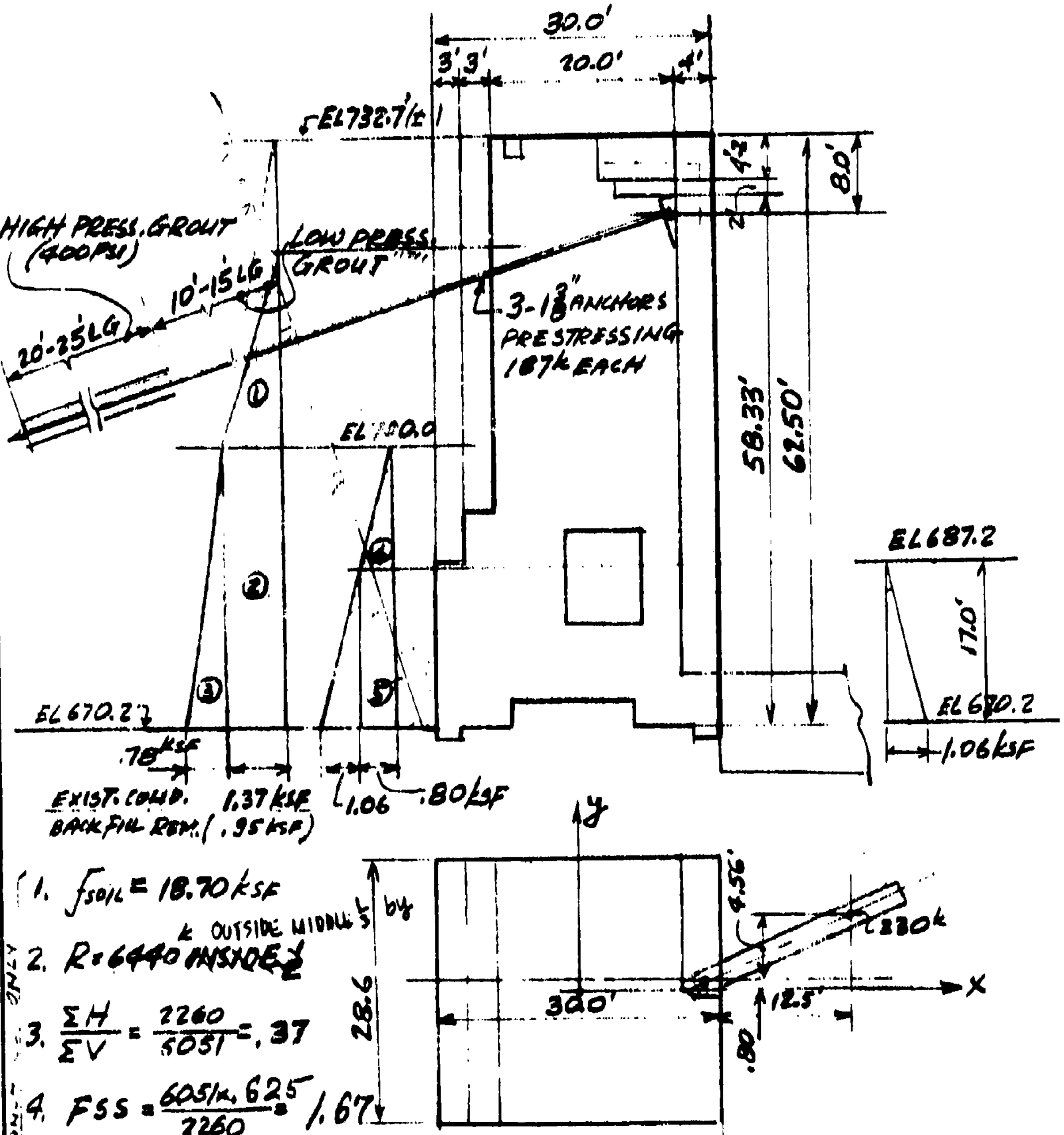
LANDWALL GATE MONOLITH #17 - STABILIZING BY ANCHORS



1. $f_{soil} = 18.70\ ksf$
2. $R = 6440^k$ OUTSIDE MIDDLE $\frac{L}{3}$ by ~~INSIDE~~
3. $\frac{\Sigma H}{\Sigma V} = \frac{2260}{6051} = .37$
4. $FSS = \frac{6051 \times .625}{2260} = 1.67$
5. $FSOT = \frac{131504}{76920} = 1.71$

LAND WALL GATE MONOLITH #17-STABILIZING BY ANCHORS, (CONT'ED)

EXISTING CONDITIONS

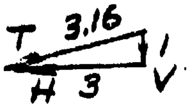
$\Sigma H_x = 2685^k$

$\Sigma V = 5910^k \quad \Sigma M_A = 31.384^{\prime k} \quad \Sigma M_{xx} = 1550^{\prime k}$

IMPROVED CONDITIONS USING 3 ANCHORS

3 - $1\frac{3}{8}''$ ANCHORS, SEE CALCS FOR MONO'S #4-15

USEFUL TENSION 148.2^k/BAR



$T = 148.2 \times 3 = 446.0^k \quad H = 425.0^k \quad V = 141.0^k$

$\Sigma V = 5910 + 141 = 6051^k$

$\Sigma H_{BOTT} = 2685 - 425 = 2260^k$

$\Sigma M_A = 31384 + 425 \times 54.50 = 31384 + 23200 = 54584^{\prime k}$

$a = \frac{54584}{6051} = 9.00'$

$e = 6.00'$

$M_{yy} = 6051 \times 6.00 = 36{,}300^{\prime k}$

$f_{soil} = \frac{2}{3} \times \frac{6051}{9.00 \times 28.6} = \underline{18.70\ ksf}$

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT LED #1
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LANDWALL GATE MONOLITH #17 - STABILIZING BY ANCHORS (CONT'ED)

IMPROVED CONDITIONS OF STABILITY BY 3 ANCHORS (CONT'ED)

$$\frac{\Sigma H}{\Sigma V} = \frac{2260}{6051} = .37$$

$$f_{SOIL} = 18.70 \text{ KSF}$$

$$FSS = \frac{6051 \times .625}{2260} = 1.67$$

$$M_A = 108.304 + 23.200 = 131.504 \text{ 'k}$$

$$M_A = 76.920 \text{ 'k}$$

$$FSOT = \frac{131.504}{76.920} = 1.71$$

$$R = 6440^k$$

(4 - $1\frac{3}{8}$ ROCK ANCHORS FSS = 1.88)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL MONOLITHS	PROJECT LED #1
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LANDWALL GATE MONOLITH #17 - STABILIZING BY BACKFILL REMOVAL (10' DEEP) AND ANCHORS (3-1 3/8" ANCHORS)

$\Sigma V = 5713 + 141 = 5854^{k}$

$\Sigma H = 1991 - 425 = 1566^{k}$

$\Sigma M_A = 46234 + 425 \times 54.50 = 69434^{'k}$

$a = \frac{69434}{5854} = 11.80$

1). $e = 3.20'$

$M_{yy} = 5854 \times 3.20 = 18700^{'k}$

$S_{yy} = \frac{1}{6} \times 30.0^2 \times 28.6 = 4290 \text{ FT}^3$

$A = 28.5 \times 30.0 = 858 \text{ FT}^2$

2). $f_{SOIL} = \frac{5854}{858} \pm \frac{18700}{4290} = 6.8 \pm 4.3 \begin{cases} MAX & 11.10 \text{ ksf} \\ MIN & 2.50 \text{ ksf} \end{cases}$

3). $\frac{\Sigma H}{\Sigma V} = \frac{1566}{5854} = .268$

4). $F_{SS} = \frac{5854 \times .625}{1566} = 2.34$

$M_A = 109.304 - 5340 + 23200 = 126.164$

$M_A = 33.290 + 23460 = 56.750^{'k}$

5). $F_{SOT} = \frac{126.164}{56750} = 2.23$

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT LANDWALL	PROJECT LFD #1
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SUMMARY

LANDWALL GATE MONO #17 - STABILIZING BY 10'-0 BACKFILL REMOVAL

1. $R = 6050^k$ OUTS. MIDDLE $\frac{1}{3}$ BY 1.90'
2. $\frac{\Sigma H}{\Sigma V} = \frac{1981}{5713} = .35$
3. $f_{SOIL} = 16.44$ KSF
4. $FSS = \frac{5713 \times .625}{1991} = 1.79$
5. $FSOT = \frac{102964}{56750} = 1.81$

LANDWALL GATE MONO #17 - STABILIZING BY 10'-0 BACKFILL - REMOVAL AND 3-1$\frac{3}{8}$" ANCHORS

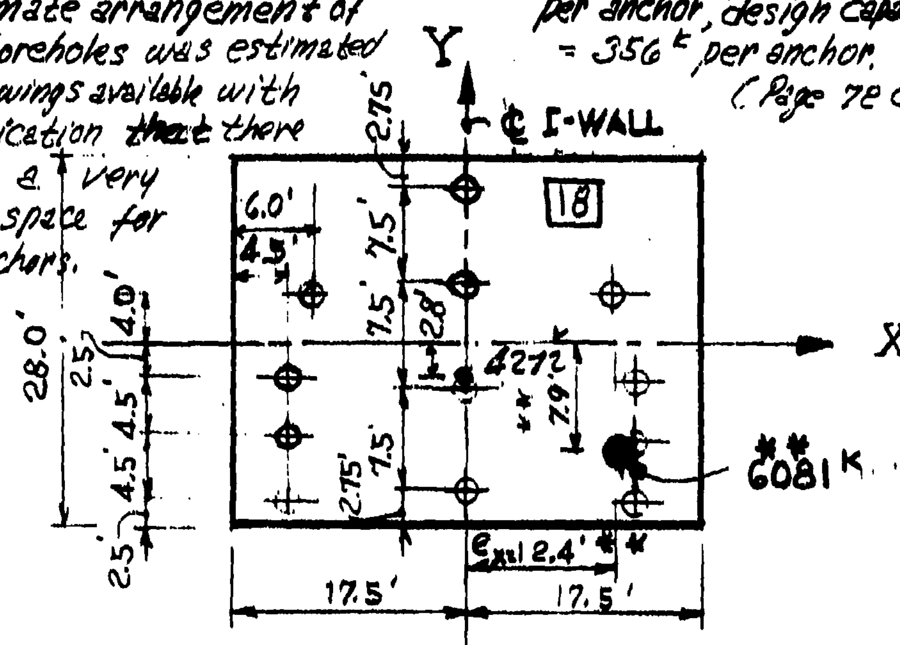
1. R INSIDE MIDDLE $\frac{1}{3}$ BY 1.80'
2. $\frac{\Sigma H}{\Sigma V} = .27$
3. $f_{SOIL} = 11.10$ KSF
4. $FSS = 2.34$
5. $FSOT = 2.23$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT I-WALL STABILITY – IMROVED – NORMAL LOADING COMPUTED R.N.M. CHECKED JI	PROJECT LOCK & DAM #1 FILE NO. 800 A DATE 3/'75 PAGE 82a OF ___ PAGES

INTERMEDIATE WALL GATE MONOLITH NO. 18
IMPROVEMENT OF STABILITY BY VERTICAL ROCK ANCHORS
NORMAL LOADING CONDITION

Assume 3-$1\frac{1}{4}$"ø Bar tendons per anchor, design capacity = 356^k per anchor. (Page 78 C)

Approximate arrangement of 5"ø ± boreholes was estimated from drawings available with the indication ~~that~~ there is only a very limited space for rock anchors.



Resultant of 12 Anchors:

** Figures taken from existing-normal loading condition, pg 40

$$\begin{array}{rcrcr} 6 & \times & 7 & = & 42 \\ 2 & \times & 18 & = & 36 \\ 4 & \times & 14 & = & 56 \\ \hline 12\ h & & & = & 134 \end{array}$$

$h = 11.2$ $\quad y = -\underline{\underline{2.8}}\ ft$

$12 \times 356 = 4272$ ↓

From existing condition, pg 40

~~ΣH~~ $= 3650^k$ $\quad V = 6081^k$ $\quad x = 12.4'$ $\quad y = -7.9'$

4267

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT I-WALL STABILITY- IMPROVED - NORMAL LOADING	PROJECT L & D #1
	COMPUTED R.N.M. CHECKED [illegible]	FILE NO 800 A
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I-WALL GATE MONOLITH 18
IMPROVEMENT OF STABILITY BY VERTICAL ANCHORS
NORMAL LOADING CONDITION (Cont'd)

Location of Resultant:

$$(\cancel{[illegible]}\ 4272) \times 2.8 = (\cancel{[illegible]}\ 11962)$$
$$\underline{6081} \times 7.9 = \underline{48040}$$

$$\Sigma V = (\cancel{[illegible]}\ 10353)^K \quad e_y = \underline{5.8'} \quad (\cancel{[illegible]}\ 60002'K) = \Sigma M_x$$

$$(\cancel{[illegible]}\ 4272) \times 0 = 0$$
$$\underline{6081} \times 12.4 = \underline{75400} = \Sigma M_Y$$

$$(\cancel{[illegible]}\ 10353) \quad e_x = (\cancel{7.2}\ 7.3') \quad \underline{75400}$$

Bearing pressures: ("Foundation Design")

$$\frac{e_x}{35} = 0.208 \qquad \frac{e_y}{28} = 0.207 \qquad K = 4.5$$

(1) $f_{max} = \dfrac{K\,\Sigma V}{A} = \dfrac{4.5 \times 10353}{980} = \underline{47.54}$ KSF

(2) Resultant is outside of "KERN"

(3) Sliding factor (along x-axis) $= \dfrac{3650}{10353} = \underline{0.353}$

(4) Sliding factor of safety $= \dfrac{0.625}{0.353} = \underline{1.77}$

Conclusion: Refering to results on page 41, bearing pressure decreased by 36%, but it's still too high.
∴ Stabilizing by interconnection of 3 monoliths is recommended.

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL DOWNSTREAM GATE MONO #18	PROJECT LSD #1
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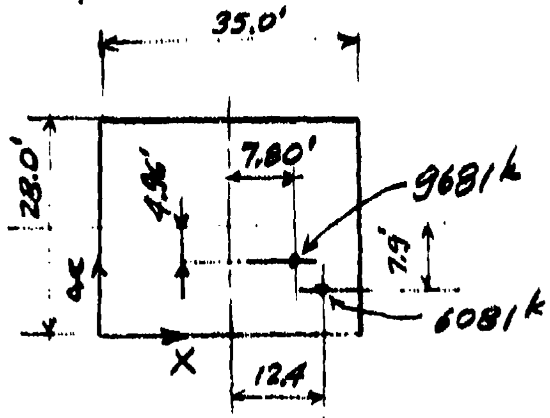
STABILIZATION OF INTERM. WALL GATE MONO. #18

~~12 - ANCHORS WITH 300 KIPS CAPACITY EACH~~



$M_{xx} = 37606^{1k}$ $y = 6.1'$

$M_{yy} = 181{,}105^{1k}$ $x = 29.9'$

$\Sigma V = 6081 + 3600 = 9681^k$

$x' = \frac{6081 \times 12.4}{9681} = 7.8'$

$y' = \frac{6081 \times 7.9}{9681} = 4.96'$

$\frac{e_x}{a} = \frac{7.8}{35.0} = .22$ $\frac{e_y}{b} = \frac{4.96}{28.0} = .18$

$C = 4.2$ $f_{soil} = 4.2 \frac{9681}{980} = 41.5\ ksf$

$FSOT = \frac{9681 \times 17.5}{102.600} = 1.65$

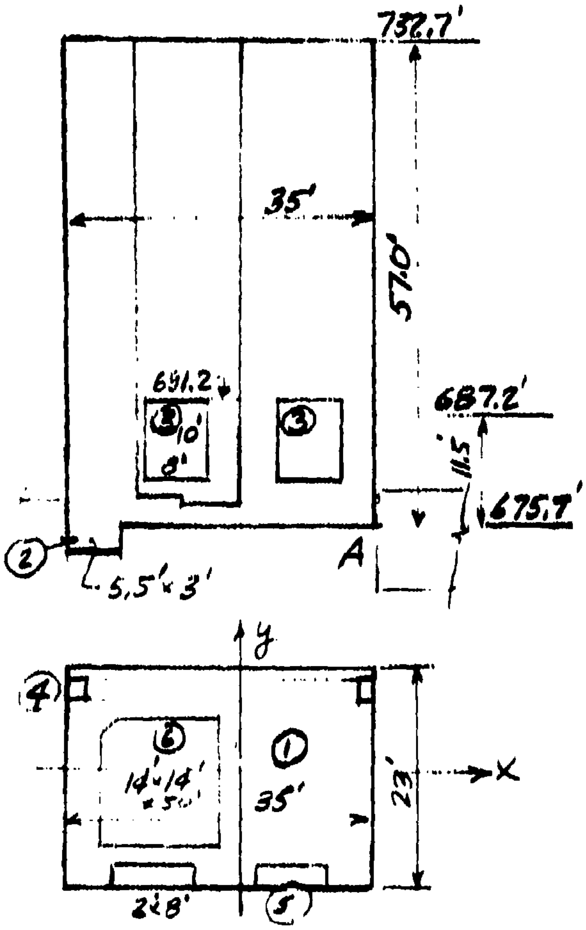
$FSS = \frac{9681 \times .625}{3650} = 1.66$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH #18 COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE NO 800A DATE 12.74 PAGE 84 OF PAGES

INTERMEDIATE WALL GATE MONOLITH #18

MONO'S #17, 18, 19 INTERCONNECTED

MONOLITH #19



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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH #18	PROJECT LED #1
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INTERMEDIATE WALL GATE MONOLITH #18 (CONT'ED)

MONOLITHS #18 & #19 INTERCONNECTED (CONT'ED)

MONOLITH #19

	LOADS KIPS	V↓	V↑	ARM	M_{xx} ↶	M_{xx} ↷	M_{yy} ↶	M_{yy} ↷
1	35×23×57×.15	6883						
2	5.5×3×23×.087	33		14.75			487	
3	2×80×23×.15		552					
3	2×6×8×23×.063	139						
4	4.5×3.08×50		693	8.5		5890		
5	4×8×53.5×.15		257	10.5	2698			
5	4×8×12.3×.063	25		10.5		263		
6	$\left(14^2-\frac{2.5^2}{2}\right)\times 53\times .15$		1533	6.5				9964
6	$\left(14^2-\frac{2.5^2}{2}\right)\times 7\times .063$	85		6.5			553	
W_1	11.5×.063×2×35		583					
		Σ 7166	3618		2698	6153	1040	9964
		ΣV = 3548↓			Σ 3455 ↷		Σ 8924 ↷	

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONO. #18 & MONO. #19 COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE NO. 800A DATE 12.74 PAGE 86 OF ___ PAGES

INTERMEDIATE WALL GATE MONO #18 & MONO #19 - INTERCONNECTED (BY SHEAR KEYS)

MONOLITH #18

$M_{yy} = 6081 \times 12.4 = 75500^{\prime k}$

$M_{xx} = 6081 \times 7.90 = 48100^{\prime k}$

$V = 6081^{k}$ AREA $35 \times 28 = 980\ FT^2$

MONOLITH #19

$M_{yy} = 3548 \times 2.51 = 8920^{\prime k}$

$M_{xx} = 3548 \times 0.97 = 3450^{\prime k}$

$V = 3548^{k}$ AREA $23 \times 35 = 805\ FT^2$

6081

$3548 \times (\overset{18.57}{12.47 + 6.1}) = 66{,}000$

9629

$y_1 = \frac{66000}{9629} = 6.85'$

$6081 \times 12.4 = 75400$

$3548 \times 2.51 = 8910$

$84310^{\prime k}$

$x_1 = \frac{84310}{9629} = 8.75'$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH #18	PROJECT L&D #1
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INTERMEDIATE WALL GATE MONOLITH #18, INTERCONNECTED WITH MONOLITH #19 (CONT'D)

MONOLITH #19 $\Sigma V = 3548^k$

$\Sigma M_{xx} = 3455^{'k}$

$\Sigma M_{yy} = 8924^{'k}$

$$e_y = \frac{3455}{3548} = 0.97'$$

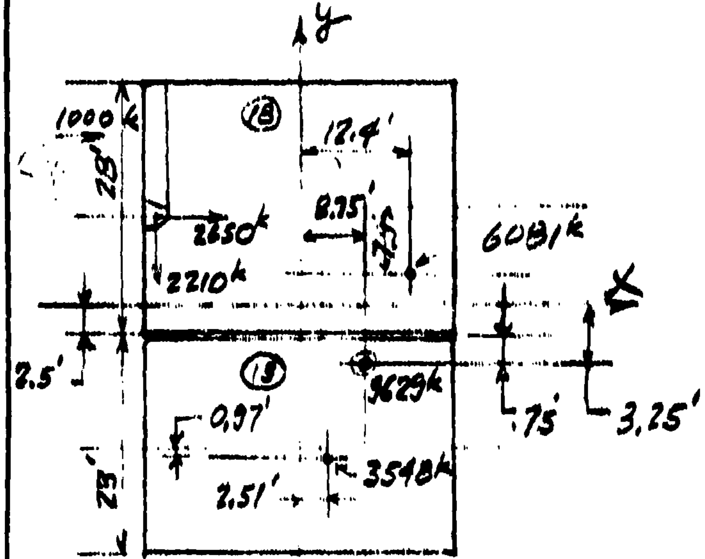
$$e_x = \frac{8924}{3548} = 2.51'$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONO #18 & MONO #19	PROJECT LGD #1
	COMPUTED M.J. CHECKED R.N.M.	FILE No. 800H
		DATE 12.74 PAGE 88 OF ___ PAGES

INTERMEDIATE WALL GATE MONO #18 & MONO #19 -

INTERCONNECTED (CONT'D)

(BY SHEAR KEYS)



$H_x = 3650^k \rightarrow$

$H_y = 2210^k \downarrow$

RESULTANT $H = 4280^k$

$M_{xx} = 9629 \times 3.25 = 31400'^k$

$M_{yy} = 9629 \times 8.75 = 84200'^k$

1). RE[illegible]NT @ MIDDLE $\frac{1}{3}$

2). $\frac{\Sigma H}{\Sigma V} = \frac{4280}{9629} = .445$

3). $FSS = \frac{9629 \times .626}{4280} = 1.41$ (A[illegible] RESISTED BY FLOOR)

4). $f_{soil} = 3.25 \times \frac{6081}{28 \times 35} = 20.10$ KSF $\qquad c = 3.25$

$\frac{e_x}{b_1} = \frac{8.75}{35.0} = 0.25 \qquad \frac{e_y}{b_2} = \frac{3.25}{51.0} = .064$

5). $FSOT = \frac{134170}{102400} = 1.31$ (197541) / (113600) = 1.75

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONO #18 & MONO #19 COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE No. 800A DATE 12.74 PAGE 89 OF PAGES

INTERMEDIATE WALL GATE MONO #18 & MONO #19 INTERCONNECTED (CONT'D)

(BY SHEAR KEYS)

OVERTURNING STABILITY

MONOLITH WT. 6634 K M_{yy} = 116,900 'K a = 17.5' @ ℄

$\overset{\curvearrowright}{M}$ = 1380 × 20.0 + 54,300 + 583 × 17.5 + 20,500 = 102,400 'K 112,600 'K

$\overset{\curvearrowleft}{M}$ = (6634 MONO + 470 GATES) × 17.5 + 440 × 17.5 + 4131 × 15.34 + 2470 = 134,170 'K 197,540

WATER IN CULVERTS AND GATE SLOTS

8 × 10 × 28 × .063 = 141 K 141 + 85 = 226 K

8 × 6 × 28 × .063 = 85 K 141 − 85 = 56 K

GATE SLOTS 13.5 × 4.0 + (2 × 4 − 2) = 54.0 + 6 = 60.0 FT²

60 × 8.5 × .063 = 37 K 176 + 37 = 213 K

60 × 46.5 × .063 = 176 K 176 − 37 = 139 K

$\overset{\curvearrowleft}{M_{yy}}$ = 56 × 5.5 + 139 × 15.5 = 308 + 2160 = 2470 'K

$$FSOT = \frac{134170}{102400} = 1.31$$

(revised: 197,540 / 112,600 = 1.75)

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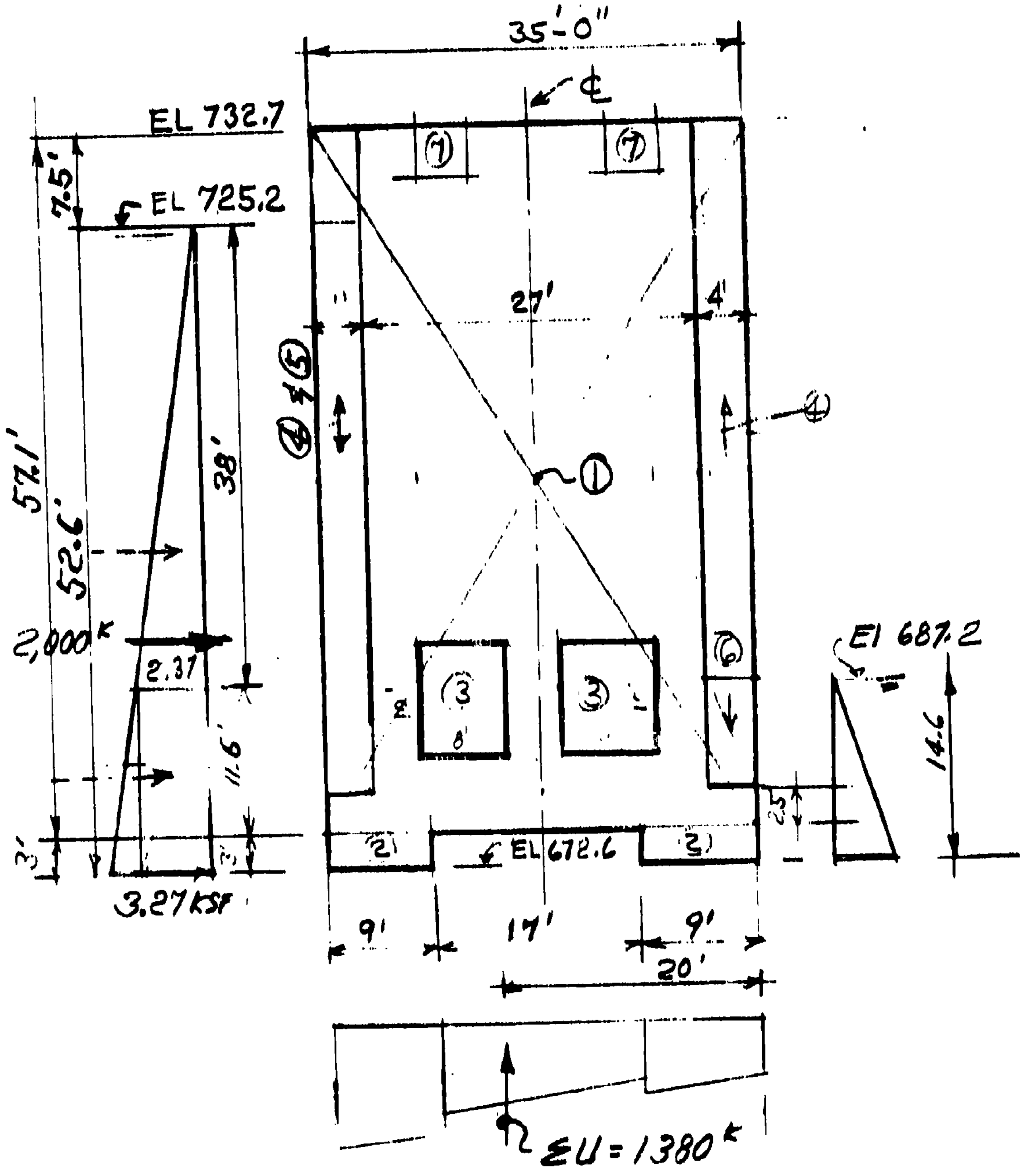
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH #18 COMPUTED RNM CHECKED	PROJECT LOCK & DAM #1 FILE No 800A DATE PAGE 90 OF PAGES

MONOLITH 17



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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH # 18	PROJECT LOCK & DAM # 1
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FORCES IN MONOLITH # 17

	$V \downarrow$ (+)	x	y	M_{Y-Y}	M_{X-X}
(1) 35 x 57.1 x 28 x 0.15	+8394 ↓	0	0	0	0
(2) 9 x 3 x 2 x 28 x 0.15	+227 ↓	0	0	0	0
- (3) 80 x 2 x 28 x 0.08 -80x2x28x.15= -672 2x8x8x28x.085 (172) } = -500	-358 ↑ (500)	0	0	0	0
- (4) 54.6 x 4 x 2 x 19.5 x 0.15	-1278 ↑	0	4.25	0	-5432
(5) 47.1 x 4 x 19.5 x 0.063	+231 ↓	15.5	4.25	-3581	+982
(6) 12.1 (8.7) x 4 x 19.5 x 0.063	+ 59 ↓ (42)	15.5	4.25	+915	+251
(7) 4.7 x 4 x 2 x 28 x 0.15	- 158 ↑	0	0	0	0
SUB TOTAL =	+7117 (6960)			-2666 (2930)	-4199 (4270)
UPLIFT =	-1380	2.5	0	+3450	0

$H_x = \left(\frac{2.37 \times 3}{2} + 2.37 \times 11.1\right) = 71.6$

$H = 71.6 \times 28 = 2000^K$ — — — — +41,000

$\Sigma H = 2{,}000^K \rightarrow$

$\Sigma V = 5737^K \downarrow$ (5530)

$\Sigma M_{Y-Y} = +41{,}784$

$\Sigma M_{X-X} = -4199$

$e_x = \frac{41784}{5737} = 7.28' > \frac{L}{6}$ (7.4)

$e_y = \frac{4199}{5737} = 0.73'$ (.757)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH #18	PROJECT L&D #1
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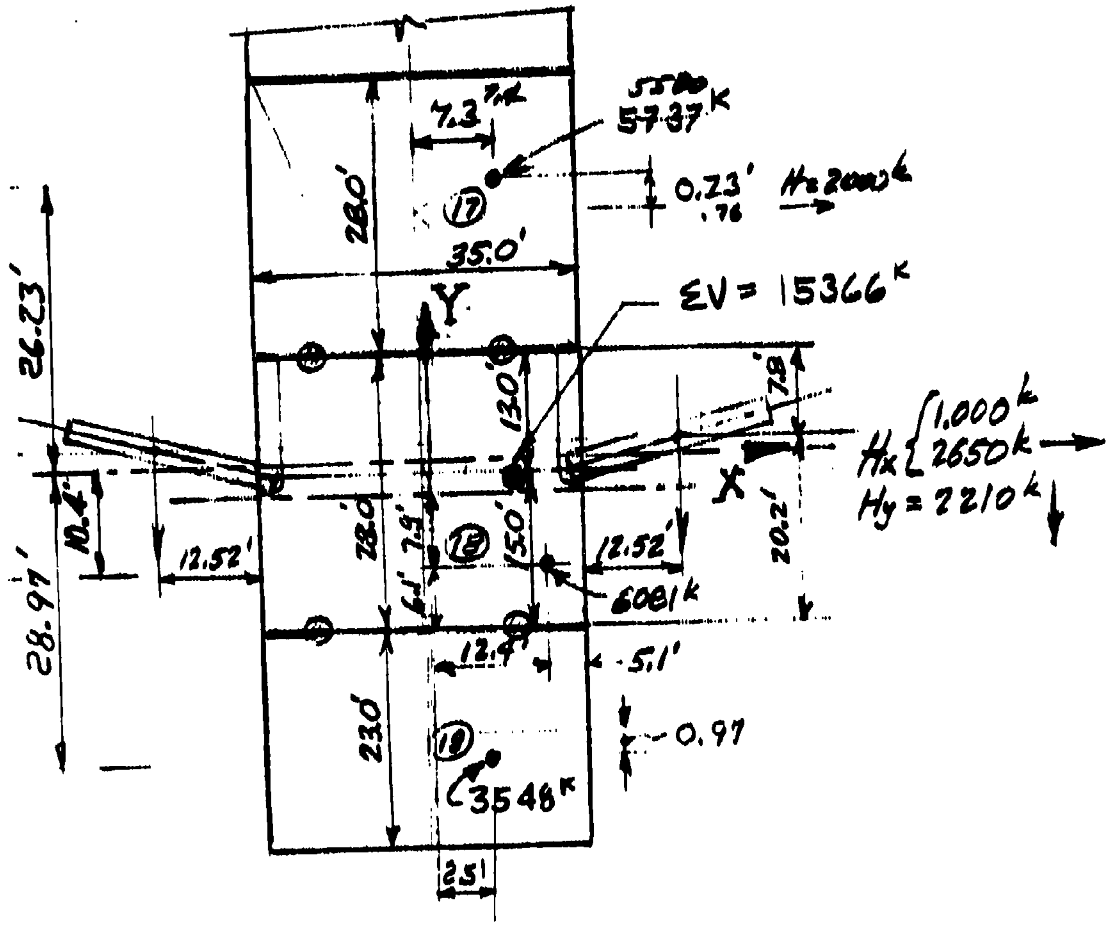
INTERMEDIATE WALL GATE MONOLITH #18-IMPROVED CONDITIONS OF STABILITY BY INTERCONNECTING MONO'S #17, 18 & 19



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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH #18 & MONO'S 17&19 COMPUTED M.J. CHECKED R.N.M.	PROJECT LED #1 FILE No. 800A DATE 12.74 PAGE 93 OF ___ PAGES

INTERMEDIATE WALL GATE MONO #18 & MONO'S #17 & 19

INTERCONNECTED BY SHEAR KEYS.

OVERTURNING STABILITY

181,720'k

$$M^{?} = \overset{112,600}{102,400} + 1260 \times 27.27 + 960 \times 7.3 + 1380 \times \overset{20}{2.5} = 147,380$$

$$H = \left(2.37 \times \overset{45}{38.0}/2 + 2.37 \times \overset{34.4}{14.5}\right) \times 28 = 1260 + 960 = 2220^{k}$$

$$FS_{OT} = \frac{6960 \times 17.5 + \overset{197540}{134170}}{\underset{181720}{147380}} = \frac{\overset{319340}{256170}}{\underset{181720}{147380}} = \overset{1.76}{1.74}$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL GATE MONOLITH #18 & MONO'S 17 & 19 COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE NO. 800A DATE 12-74 PAGE 94 OF ___ PAGES

INTERMEDIATE WALL GATE MONO #18 & MONO'S #17 & 19

INTERCONNECTION BY SHEAR KEYS (CON'T'D)

$$M_{yy} = 5580 \times 7.4 + 6081 \times 12.4 + 3548 \times 2.5 = 125{,}590^{\prime k}$$

$$e_x = \frac{125{,}590}{15210} = 8.3'$$

$$\Sigma V = 5580 + 6081 + 3548 = 15{,}210^k$$

1). RESULTANT ~~INSIDE~~ OUTSIDE MIDDLE $\frac{1}{3}$ BY ~~0.21~~ 2.46'

2). $\frac{\Sigma H}{\Sigma V} = \frac{5650}{15210} = .37$

3). $FSS = \frac{15210 \times .625}{5650} = 1.68$

4). $f_{soil} = 2.60 \times \frac{6081}{35 \times 28} = 16.1\,ksf$ or $\frac{2}{3} \times \frac{6081}{9.2 \times 28} = 15.7\,ksf$

$\frac{e}{b} = \frac{8.30}{35.0} = .238 \qquad C = 2.60 \qquad a = 17.5 - 8.3 = 9.2$

5). $FSOT = \frac{256170}{147380} = 1.74$

55[illegible]	× [illegible]	=	146363
6081	× [illegible]	=	63242
3549	× [illegible] 17	=	102786
15201			19665

$\bar{y} = \frac{19665}{15201} = 1.29$

$f_{soil} = 2.5 \times \frac{15201}{35 \times 79} = 13.9\ KSF$

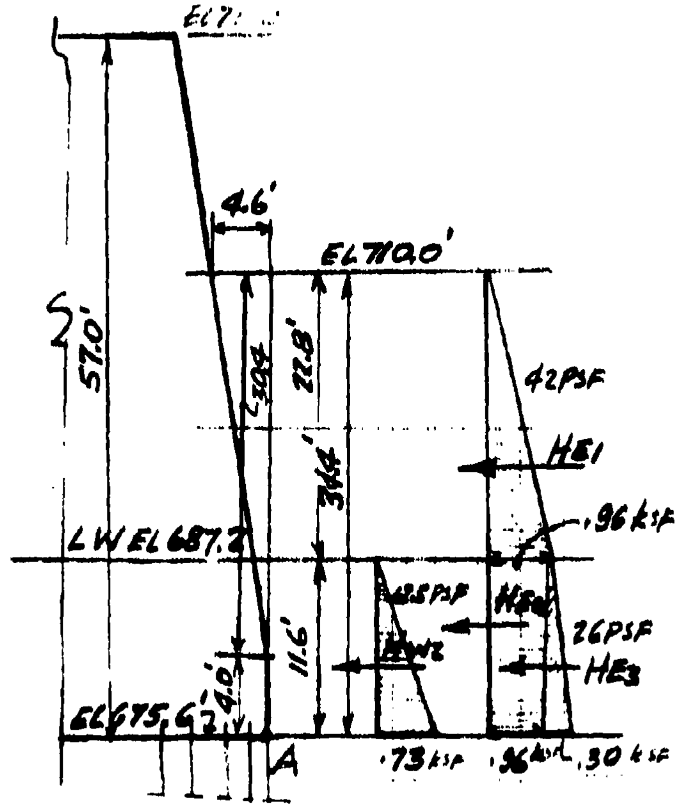
$\frac{e_x}{e_b} = \frac{8.3}{35} = .239 \qquad \frac{e_1}{I} = \frac{1.29}{79.0} = .016 \qquad K = 2.5$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVING CONDITIONS OF STABILITY @ RIVER WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT LED #1 FILE No. 800A DATE 10.74 PAGE 95 OF PAGES

RIVER WALL MONOLITH #19

BACKFILLING RIVERSIDE UP TO EL 710.0'



	SHEAR	ARM	MOMENT @ "A"
$H_{W2} = .73 \times \frac{11.6}{2} \times 28$	$= 118.0^k$	3.88	$460.0^{'k}$
$H_{E1} = .96 \times 11.4 \times 28$	$= 307.0^k$	19.20	5900.0
$H_{E2} = .96 \times 11.6 \times 28$	$= 312.0^k$	5.80	1810.0
$H_{E3} = .15 \times 11.6 \times 28$	$= 48.8^k$	3.88	189.0
	$\Sigma H = 785.8^k$		$\Sigma M_A = 8359.0^{'k}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVING CONDITIONS OF STABILITY @ RIVER WALL	PROJECT L&D #
	COMPUTED M.J CHECKED R.N.M.	FILE No. 800 A
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RIVER WALL MONOLITH #19 (CONT'ED)

BACKFILLING RIVERSIDE UP TO EL 710.0' (CONT'ED)

$\Sigma H = \overrightarrow{2150} - \overleftarrow{786} = \overrightarrow{1364}^{k}$

$\Sigma M_A = 110{,}280 - 39{,}600 + 8360 - 21{,}840 = 57{,}200^{\prime k}$

$\Sigma V = 5059^{k}$

LOAD ON TIMBER PILES FROM AVERAGE HYDROSTATIC

LOCKSIDE LOAD

$P = 51.10 \pm \frac{23800}{725} = 51.1 \pm 32.8$

$a = \frac{57{,}200}{5059} = 11.3'$ $e = 4.7'$

$M_{\mathcal{L}} = 23{,}800^{\prime k}$ $H = \underline{\overrightarrow{1364}}^{k}$

$\underline{P_{MAX} = 83.9^{k}}$

$\underline{P_{MIN} = 18.3^{k}}$ $H_p = \frac{1364}{99} = \overrightarrow{13.8}\ {}^{k}/_{pile}$

SEE LOAD ON TIMBER PILES ON PAGE 96 a WHERE STEEL SHEET PILING IS NEGLECTED

AREA LOADING FOR THE SAME CONDITION

$\frac{32}{6} = 5.33$
$\underline{4.70}$
$.63$

1). RESULTANT INSIDE MIDDLE $\frac{1}{3}$ BY $\overset{0.63}{\cancel{0.14}}'$

2). $f_{SOIL} = \overset{10.61}{\cancel{12.20}}$ KSF (MAX) ; $\overset{.66}{\cancel{0.20}}$ KSF MIN

3). $\frac{\Sigma H}{\Sigma V} = \frac{1364}{5059} = \underline{.270}$ (<.367)

4). $FSS = \frac{5059 \times .55}{1364} = 2.04$

5). $FSOT = 118640/61440 = \underline{1.93}$

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVING CONDITIONS OF STABILITY @ RIVER WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE No. 800A DATE 10.74 PAGE 97 OF ___ PAGES

RIVERWALL MONOLITH #19 (CONT'ED)

BACKFILLING RIVERSIDE UP TO EL 710.0' (CONT'ED)

LOAD ON TIMBER PILES FROM MAX. HYDROST. LOCKSIDE LOAD !!!

$\Sigma H = 2150 - 786 = 1364^k$

$\Sigma V = 4530^k$

$M_A = 110280 - 39600 + 8360 - 33150 = 45900^{\prime k}$

$a = \frac{45900}{4530} = 10.13 \qquad e = 5.87'$

$M_{\mathcal{C}} = 26600^{\prime k}$

PILE LOAD

$P = 45.6 \pm \frac{26600}{725} = 45.6 \pm 36.7$

$P_{MAX} = 82.3^k \quad P_{MIN} = 8.9^k$

SEE PAGE 96 G FOR TIMBER PILE LOADS WHERE STEEL SHEET PILING IS NEGLECTED

AREA LOADING

1). RESULTANT OUTSIDE MIDDLE 1/3 BY ~~1.04~~ .53'

2). $f_{SOIL} = \frac{2}{3} \times \frac{4531}{\cancel{8.63}\ 10.13 \times 28.0} = \cancel{12.50}\ 10.70\ ksf$

3). $\frac{\Sigma H}{\Sigma V} = \frac{1364}{4531} = .302\ (\angle 367)$

4). $FSS = \frac{4531 \times .55}{1364} = 1.83$

5). $FSOT = 118640/72750 = \underline{1.63}$

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY- PILE LOAD COMPUTED R.N.M. CHECKED JJ	PROJECT L & D #1 FILE NO. 800 A 98 DATE 3/'75 PAGE 969 OF PAGES

RIVER WALL MONOLITH No 19
IMPROVE, NORMAL LOADING CONDITIONS FOR PILE LOADING
BACK FILL RIVERSIDE UP TO EL 710'

"LOCK SIDE AVERAGE" *Reference page 96*

For 3' wall,

$$\Sigma V = 5059 \times \frac{3}{28} = 542^k \downarrow \qquad I = 540\ ft^4$$

$$S = 45\ ft^3$$

$$\Sigma M_{\text{¢}} = 23{,}800 \times \frac{3}{28} = 2550^k$$

$$\Sigma H = 1364 \times \frac{3}{28} \quad 146^k \rightarrow \qquad P_H = 16^k$$

$$P_{MAX.} = \frac{542}{9} + \frac{2550}{45} = 60 + 57 = \underline{117}^k$$

$$P_{MIN.} = \text{-----------} \; 60 - 57 = \underline{3}^k$$

"LOCKSIDE MAXIMUM" *Reference page 97*

3' strip of wall:

$$\Sigma V = 4530 \times \frac{3}{28} = 486^k$$

$$\Sigma M_{\text{¢}} = 26{,}600 \times \frac{3}{28} = 2850'k$$

$$\Sigma H = 1364^k \times \frac{3}{28} = 146^k \qquad P_H = 16^k$$

$$P_{MAX.} = \frac{486}{9} + \frac{2850}{45} = 54 + 63 = \underline{117}^k$$

$$P_{MIN.} = \text{-------} \; 54 - 63 = \underline{-9}^k$$

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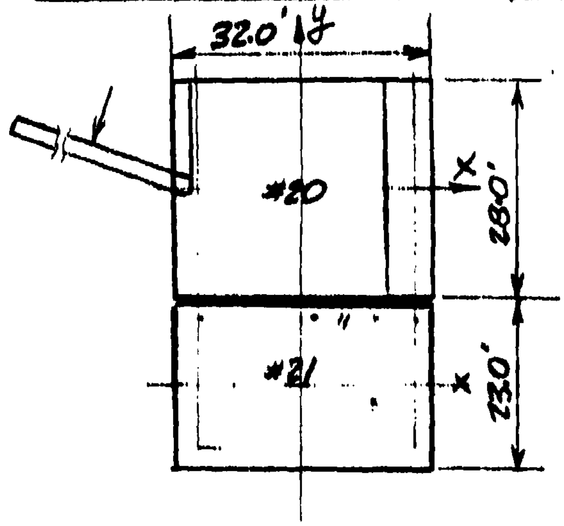
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVING CONDITIONS OF STABILITY @ RIVER WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT L & D #1 FILE No 800 A DATE 10.74 PAGE 99 OF ___ PAGES

RIVER WALL GATE MONOLITH #20

ASSUME MONOLITHS #20 & #21 INTERCONNECTED



WEIGHT OF MONOLITH #21

① $24.0 \times 57.0 \times 23.0 \times .15 = 4750$

② $4.0 \times 57.0 \times 23.0 \times .15 = 788$

③ $9.0 \times 4.0 \times 23.0 \times .087 = 72$

④ $-80.0 \times 23.0 \times .15 = -276$

5334^k

ASSUMED PILING $9 \times 8 = 72 + 2 \times 8 = 88$ (ASS'D FOR SWT. PILING)

PILE LOADING MONOLITH #21 - EXISTING CONDITION

UPLIFT LOAD $32 \times 23.0 \times .73 = 538^k$

$(5334 - 538)/88 = 54.5\ ^k/\text{PILE}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVING CONDITIONS OF STABILITY C RIVER WALL COMPUTED M.J. CHECKED R.N.N.	PROJECT L&D #1 FILE NO. 800A DATE 10.74 PAGE 100 OF PAGES

RIVER WALL GATE MONOLITH #20 (CONT'ED)

ASSUME MONOLITHS #20 & #21 INTERCONNECTED

$$
\begin{aligned}
I_{xx} = \; & 72 \times 3.0^2 = 108 \\
& 22 \times 6.0^2 = 792 \\
& 22 \times 9.0^2 = 1780 \\
& 22 \times 12.0^2 = 3180 \\
& 22 \times 15.0^2 = 4960 \\
& 22 \times 18.0^2 = 7130 \\
& 22 \times 21.0^2 = 9700 \\
& 22 \times 24.0^2 = 12700 \\
& \qquad 40{,}440 \text{ FT}^4
\end{aligned}
$$

$$S_{xx} = \frac{40440}{24} = 1680 \text{ FT}^3$$

$$
\begin{aligned}
I_{yy} = \; & 2 \times 17 \times 3.0^2 = 306 \\
& 2 \times 17 \times 6.0^2 = 1220 \\
& 2 \times 17 \times 9.0^2 = 2750 \\
& 2 \times 17 \times 12.0^2 = 4900 \\
& 2 \times 17 \times 14.5^2 = 7150 \\
& \qquad 16326
\end{aligned}
$$

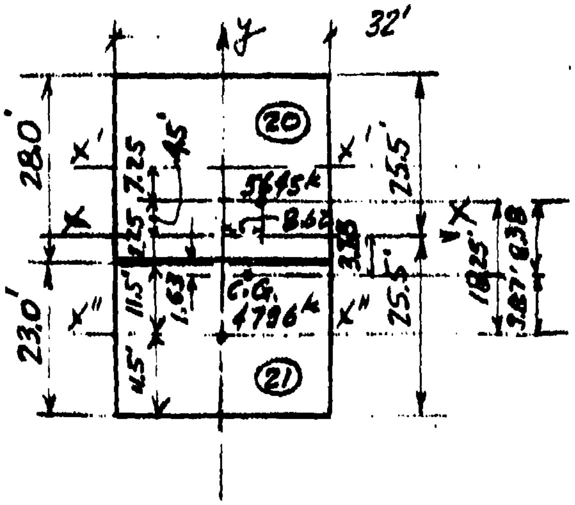
$$S'_{yy} = \frac{16326}{14.5} = 1133 \text{ C SHEET PILES}$$

$$S_{yy} = \frac{16326}{12} = 1360 \text{ C TIMBER PILES}$$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVING CONDITIONS OF STABILITY @ RIVER WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT L&D #1 FILE No. 800 A DATE 10.74 PAGE 101 OF ___ PAGES

RIVER WALL GATE MONOLITH #20 (CONT'D)

ASSUME MONOLITHS #20 & 21 INTERCONNECTED (CONT'D)



CENTER GRAVITY OF LOADS

5645	× 0	= 0
4796	× 18.25	= 88.700
10441		88.700

$y = \frac{87.500}{10441} = 8.33'$

$M_{xx} = 10.441 \times 4.13 = 43,300\ ^{1k}$

$P = \frac{10441}{187} \pm \frac{43300}{1680} \pm \frac{48550}{1360} = 55.83 \pm 25.80 \pm 11.94$

MAX PILE LOAD $P = 117.3^k$/PILE

MIN PILE LOAD $P = -5.7^k$/PILE

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY ANALYSIS C RIVER WALL	PROJECT LED #1
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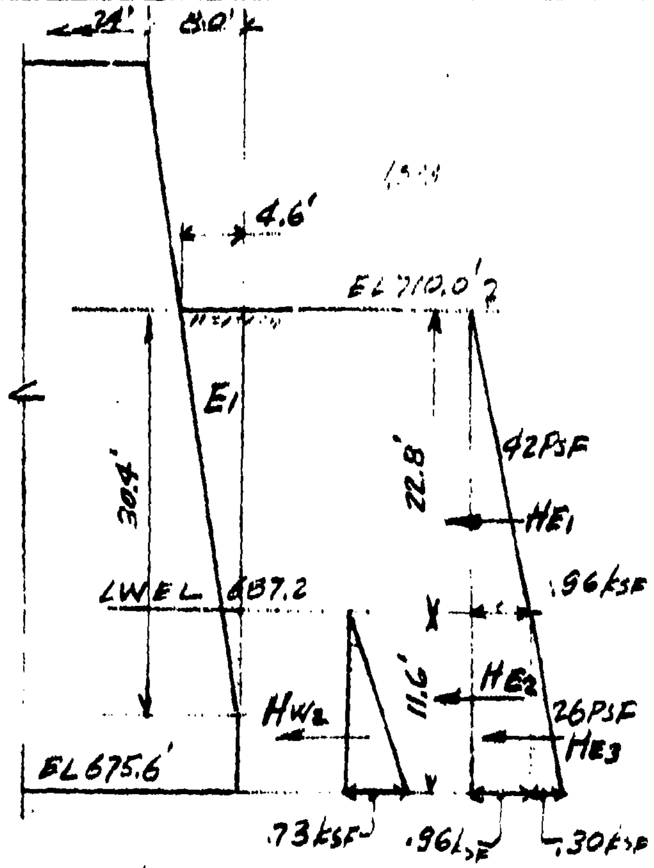
RIVERWALL GATE MONOLITH #20 (CONT'ED)

BACKFILLING RIVERSIDE UP TO EL 710.0'



H_{W2}	118.0^k		$\times 3.98 = 460.^{1k}$	
H_{E1}	307.0^k		$13.20 = 5900.$	8359.0'k
H_{E2}	312.0^k	$\underline{667.8^k}$ ≈ 668	$5.80 = 1810.$	
H_{E3}	48.8		$3.88 = 189.$	

$E1 \quad 4.6 \times 30.4/2 \times 28 \times .116 = 228 \times 14.47 = 3300.^{1k}$

$\Sigma M'_{yy} = 8359.0 - 3300 = 5060^{1k}$

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY ANALYSIS @ RIVER WALL	PROJECT LED #1
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RIVER WALL GATE MONOLITH #20 (CONT'D)

BACKFILLING RIVERSIDE UP TO EL 710.0' (LOCKSIDE AVERAGE)

$\Sigma M'_{yy} = 5060 - .73 \times 5.8 \times 28 \times 3.87 - .117 \times 1.4 \times 28 \times 12.5 - .117 \times 11.6 \times 28 \times 5.8$
$- .151 \times 11.6 \times 28 \times 3.9 =$
$= 5060 - 930 = 4130^{1k}$

14470 $\Sigma M_{yy} = 40550 - 4130 = 44420^{1k}$

$\Sigma M_{xx} = 40.820^{1k}$

$\Sigma V = 5645 + 228 = 5873^k \downarrow$

$\Sigma H_x = 2684^k$

$\Sigma H = \sqrt{2684^2 + 2050^2} = 3380^k$

PILE LOADING

$P = 5873/99 \pm \frac{40820}{495} \pm \frac{44420}{600} = 59.4 \pm 82.4 \pm 73.8$

MAX P $= 215.6^k$

MIN P $= -96.8^k$

FOR PILE LOADS WITHOUT SHEET PILING, Pp 103a; 105

AREA LOADING FOR THE SAME CONDITION

$e_y = \frac{40820}{5873} = 6.95 \qquad e_x = \frac{44420}{5873} = 7.55$

$\frac{6.95}{28.0} = .25 \qquad \frac{7.55}{29.0} = .26 \qquad A = 29 \times 28 = 812\ FT^2$

$K = 6.30$

$f_{soil} = 6.30 \times \frac{5873}{812} = 45.50\ ksf$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY PILE LOAD	PROJECT L&D #1
	COMPUTED JI CHECKED R.N.M.	FILE No 802A DATE 3/75 PAGE 103a OF PAGES

RIVER WALL GATE MONOLITH #20
RIVERSIDE BACKFILLED UP TO EL.710.0'

"LOCKSIDE AVERAGE" (REF. p.103)

$\Sigma V = 5873^k$

$\Sigma M_{xx} = 40820^{'k}$ $\Sigma M_{yy} = 44420^{'k}$

$\Sigma H_x = 2684^k$ $\Sigma H_y = 2050^k$ $\Sigma H_R = 3380^k$

$P_V = \frac{5873}{81} \pm \frac{40820 \times 19.0}{4860} \pm \frac{44420 \times 12.0}{4860} =$

$= 72 \pm 161 \pm 110 = \begin{cases} \underline{283}^k \text{ max} \\ \underline{-139}^k \text{ min} \end{cases}$

$P_{H_x} = \frac{2684}{81} = \underline{\underline{33^k}}/\text{pile}$ $P_{H_R} = \frac{3380}{81} = \underline{\underline{42^k}}/\text{pile}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVED CONDITION OF STABILITY @ RIVER WALL COMPUTED M.J. CHECKED RNM	PROJECT L&D #1 FILE No 800A DATE 11.74 PAGE 104 OF ___ PAGES

RIVER WALL GATE MONOLITH #20 (CONT'D)

BACKFILLING RIVERSIDE UP TO EL 710.0'

SUMMARY OF RESULTS FOR AREA LOADING

1). $f = 45.50\,ksf$

2). $R = 6500^k$

3). $\frac{\Sigma H_x}{\Sigma V} = \frac{2684}{5873} = 0.44$

4). $Fss_{xx} = \frac{5873 \times .55}{2684} = 1.20$ $Fss_R = \frac{5873 \times .55}{3380} = 0.96$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY PILE LOAD	PROJECT L&D #1
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RIVER WALL GATE MONOLITH #20
RIVERSIDE BACKFILLED UP TO EL. 710.5'

"LOCKSIDE MAXIMUM" (REF. p. 106)

$\Sigma V = 5610^k$

$\Sigma M_x = 42690'^k \quad \Sigma M_y = 45840'^k$

$\Sigma H_x = 2684^k \quad \Sigma H_y = 2050^k \quad \Sigma H_R = 3380^k$

$P_V = \frac{5610}{81} \pm \frac{42690 \times 12.2}{4860} \pm \frac{45840 \times 12.0}{4860} =$

$= 69 \pm 105 \pm 113 = \begin{cases} 287^k \text{ max} \\ -149^k \text{ min} \end{cases}$

$P_{H_x} = \frac{2684}{81} = 33^{k/pile} \qquad P_{H_R} = \frac{3380}{81} = 42^{k/pile}$

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVED CONDITIONS OF STABILITY CRIBER WALL	PROJECT LED #1
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RIVER WALL GATE MONOLITH #20 (CONT'ED)

BACKFILLING RIVERSIDE UP TO EL 710.0 (LOCKSIDE MAXIMUM)

$\Sigma V = 5380 + 228 = 5610^k$

$\Sigma H_x = 2684^k \qquad \Sigma H_y = 2050^k \qquad \Sigma H = 3380^k$

$\Sigma M_{xx} = 42{,}690'^k$

$\Sigma M_{yy} = 49{,}970 - 4130 = 45{,}840'^k$

$FSS_{xx} = \frac{5610 \times .55}{2684} = \underline{1.15} \qquad FSS_R = \frac{5610 \times .55}{3380} = 0.92$

$e_y = \frac{42690}{5610} = 7.6'$

$e_x = \frac{45{,}840}{5610} = 8.18$

$e_y/b = 7.6/28.0 = .272$

$e_x/d = 8.18/29.0 = .282 \qquad K = 7.6$

$f_{soil} = 7.6 \frac{5610}{812} = 52.4 \, ksf$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY FOUNDATION PRESSURES COMPUTED R.N.M. CHECKED JJ	PROJECT L & D No 1 FILE NO. 800 A DATE 4/'75 PAGE 1069 OF PAGES

INTERCONNECTION OF RIVERWALL MONOLITHS 20, 19 & 21

"LOCKSIDE AVERAGE" UPLIFT

NO BACKFILL BEHIND WALLS

AREAS

[19] = 896 ft²

[20] = 896 ft²

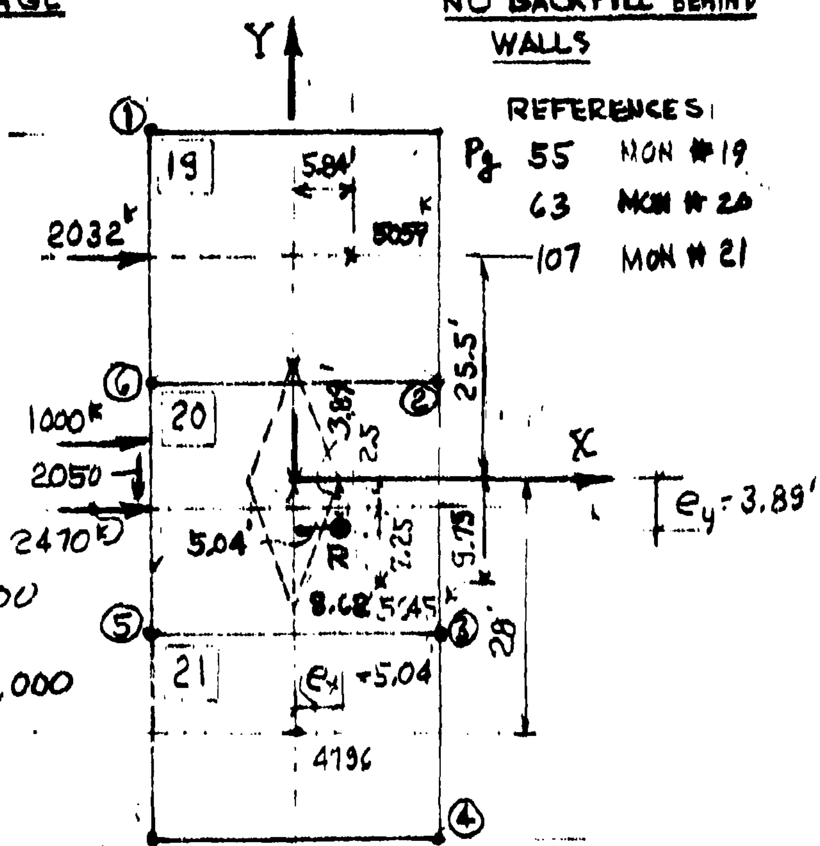
[21] = 736 ft²

REFERENCES:

Pg 55 MON #19

63 MON #20

107 MON #21



$I_Y = \frac{79(32)^3}{12} = 215{,}700$

$I_X = \frac{32(79)^3}{12} = 1{,}315{,}000$

V		ARM X	MY	ARM Y	MX
5059	×	5.84	29500	−25.5	−129,000
5645	×	8.62	48700	+9.75	+55,000
4796	×	0	0	+28.0	+134,300
R = 15500ᴷ	e_x =	5.04'	78200'ᴷ = ΣMY	e_y = 3.89'	+60300 = ΣMX

COMPUTE FOUNDATION PRESSURE AT POINTS 1, 2, 3, 4, 5 AND 6, ASSUMING NO TRANSFER OF VERTICAL LOAD BETWEEN MONOLITHS:

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY FOUNDATION PRESSURES & SLIDING COMPUTED R.N.M. CHECKED JI	PROJECT L&D #1 FILE NO 800 A DATE 4/'75 PAGE 1066 OF ___ PAGES

INTERCONNECTION OF 20, 19 & 21 (CONT'D) — NO BACKFILLING

"LOCKSIDE AVERAGE" UPLIFT

$$f_{①} = \frac{5059}{896} + \frac{\overset{M_x}{60,300}(\overset{Y_1}{-39.5})}{1,315,000} + \frac{\overset{M_y}{78,200}(\overset{X_1}{-16.0})}{215,700}$$

$$f_{①} = 5.65 - 1.81^{I_x} - 5.82^{I_y}$$

$$f_{①} = \underline{-1.98 \text{ KSF}}$$

$$f_{②} = \frac{5059}{896} + \frac{60,300(-11.5)}{1,315,000} + 5.82$$

$$f_{②} = 5.65 - 0.53 + 5.82$$

$$f_{②} = \underline{10.94 \text{ KSF}}$$

$$f_{③} = \frac{\overset{6.30}{5645}}{896} + \frac{\overset{0.76}{60,300}(16.5)}{1315000} + 5.82$$

$$f_{③} = \underline{12.88 \text{ KSF}}$$

$$f_{④} = \frac{\overset{6.52}{4796}}{736} + 1.81 + 5.82 = \underline{14.15 \text{ KSF}}$$

$$f_5 = 6.52 + 0.76 - 5.82 = \underline{1.46 \text{ KSF}}$$

$$f_6 = 6.30 - 0.53 - 5.82 = \underline{-0.05^{*} \text{ KSF}}$$

$$\begin{array}{l} 25.5 \\ +\underline{14.0} \\ 39.5 = -Y_1 \\ \underline{28.0} \\ 11.5 = -Y_2 = -Y_6 \\ \underline{28.0} \\ 16.5 = Y_3 = Y_5 \\ \underline{23} \\ 39.5 = Y_4 \end{array}$$

$X_2 = X_3 = X_4 = 16'$

$X_1 = X_5 = X_6 = -16'$

* THE TENSION PRESSURES ARE NOT CRITICAL & THEREFORE FURTHER REFINEMENT IS NOT REQUIRED

	FOUNDATION PRESSURE, KSF	
	f_{max}	f_{min}
MON. # 19	10.94	-1.98^* ←
MON # 20	12.88	-0.05^*
MON # 21	14.15 ←	1.46

RESULTANT IS OUTSIDE OF KERN

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HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVERWALL STABILITY FOUNDATION PRESSURE COMPUTED R.N.M. CHECKED JI	PROJECT L & D # 1 FILE No. 800 A DATE 4/'75 PAGE 106C OF ___ PAGES

INTER CONNECTION OF RIVER WALL MONOLITHS 20, 19 & 21

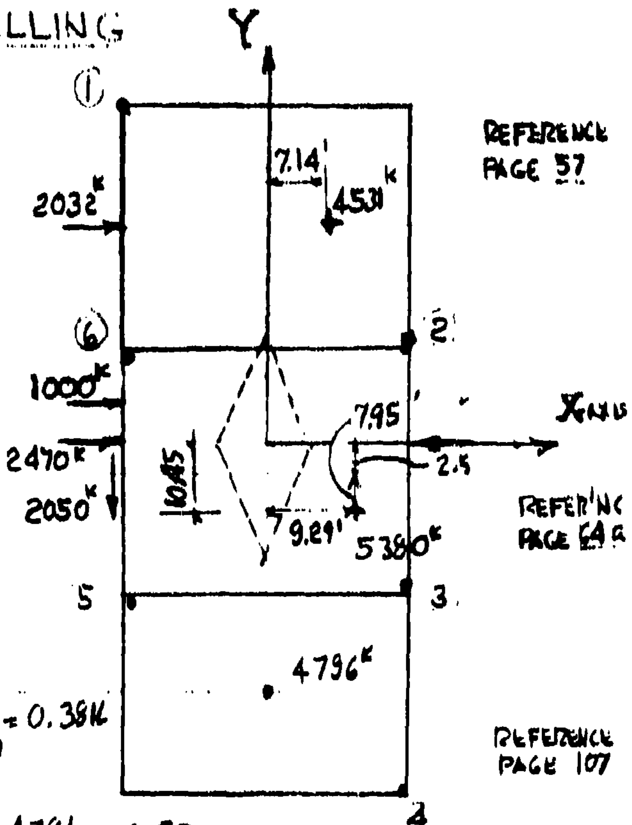
"LOCKSIDE MAXIMUM" UPLIFT

NO BACKFILLING

$I_X = 1,315,000$
$I_Y = 215,700$

4531 × 7.14 = 32351
5380 × 9.29 = 49980
4796 × 0 = 0
$\Sigma V =$ 14707^K × $e_x =$ 5.60' = $\Sigma M_Y =$ 82331'K

4531 × −25.5 = −115540
5380 × 10.45 = +56221
4796 × 28.0 = +134288
$\Sigma V =$ 14707^K × $e_Y =$ 5.10' $\Sigma M_X =$ +74969



$\frac{M_X}{I_X} = \frac{74969}{1315000} = 0.0570$; $\frac{M_Y}{I_Y} = \frac{82331}{215700} = 0.3816$

$\frac{4531}{896} = 5.06$ $\frac{5380}{896} = 6.00$ $\frac{4796}{736} = 6.52$

$f_1 = 5.06 + 0.0570\overset{-2.25}{(-39.5)} + 0.3816\overset{-6.11}{(-16)} = -3.30$ KSF

$f_2 = 5.06 + 0.0570\overset{-0.52}{(-11.5)} + 0.3816\overset{+6.11}{(16)} = +10.51$ KSF

$f_3 = 6.00 + 0.0570\overset{0.94}{(16.5)} + 0.3816(16) = 13.05$ KSF

$f_6 = 6.00 + 0.0570\overset{0.52}{(11.5)} + 0.3816\overset{-6.1}{(-16)} = -.77$ KSF

$f_4 = 6.52 + 0.0570(39.5) + 0.3816(16) = 14.88$ KSF

$f_5 = 6.52 + 0.0570\overset{0.94}{(16.5)} + 0.3816\overset{-6}{(-16)} = 1.35$ KSF

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY FOUNDATION PRESSURES & SLIDING COMPUTED R.N.M. CHECKED JI	PROJECT L & D # 1 FILE NO. 800 A DATE 4/75 PAGE 106d OF ___ PAGES

INTERCONNECTION OF 20, 19 & 21 — NO BACKFILL (CONT'D)

"LOCKSIDE MAX." UPLIFT

	FOUNDATION PRESSURE, KSF f MAX	f MIN
MONOLITH #19	10.51	-3.30 *
MONOLITH # 20	13.05	-.77 *
MONOLITH # 21	14.88	1.35

SLIDING FOR MONOLITHS 20 & 21

"LOCKSIDE AVERAGE" UPLIFT

$$\Sigma V_{20+21} = 5645 + 4796 = \underline{10441}^K$$

$$\Sigma H_X = 1000 + 2470 = 3470^K$$

$$\Sigma H_Y = 2050^K$$

$$\Sigma H_R = \underline{4030^K} \text{ (HORIZONTAL RESULTANT)}$$

SLIDING FACTOR $= \frac{4030}{10441} = .386$ F.S.S. $= \underline{1.42} < 1.5$

"LOCK SIDE MAX." UPLIFT

$$\Sigma V_{20+21} = 5380 + 4796 = 10176^K$$

$$\Sigma H_R = 4030^K$$

SLIDING FACTOR $= \frac{4030}{10176} = .396$ F.S.S. $= \underline{1.39} < 1.5$

* THE TENSION PRESSURES ARE NOT CRITICAL
∴ FURTHER REFINEMENT IS NOT REQUIRED.

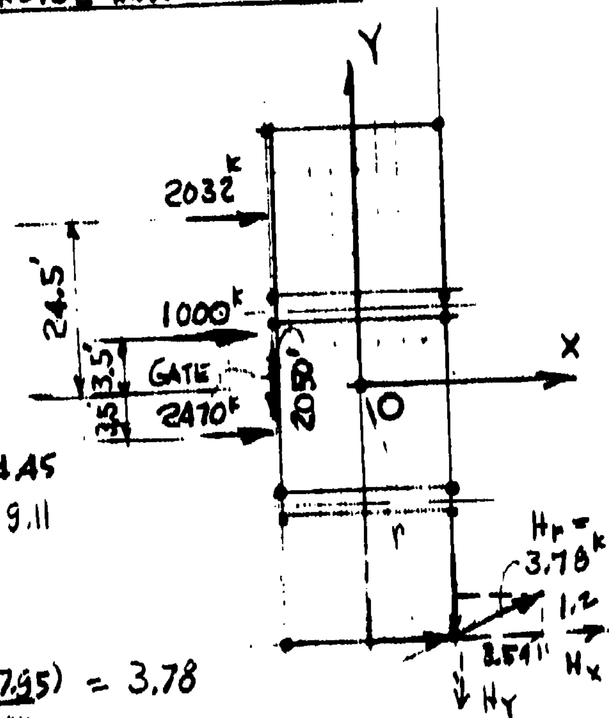
HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVERWALL STABILITY HORIZONTAL PILE LOAD COMPUTED R.H.M. CHECKED JJ	PROJECT L & D #1 FILE No 800 A DATE 4/'75 PAGE 106 e OF PAGES

INTERCONNECTION OF RIVERWALL MONOLITHS 20, 19 & 21

"LOCKSIDE MAX." & "LOCKSIDE AVE" UPLIFTS

$2032 \times 24.5 = 49784$
$1000 \times 3.5 = \underline{3500}$
$53284'^{k}$

$2470 \times (-3.5) = -8645$
$2050 \times (-16) = \underline{-32800}$
$41445'^{K}$



$\Sigma M_H = 11839'^{K}$
$\Sigma H_X = 5502^{K}$ $\quad H_X = \frac{5502}{225} = 24.45$
$\Sigma H_Y = 2050^{K}$ $\quad H_Y = \frac{2050}{225} = 9.11$

$J = I_X + I_Y = 118{,}800$
$r = 37.95$ ft
$H_r = \frac{\Sigma M_H (r)}{J} = \frac{11839(37.95)}{118{,}800} = 3.78$

H_r (X COMPONENT) $= 3.78 \times \frac{36}{37.9} = 3.59$

H_r (Y COMPONENT) $= 3.78 \times \frac{12}{37.9} = 1.20$

$3.59 + 24.45 = 28.04 \approx 28$
$1.20 + 9.11 = 10.31 \approx 10^{K}$ $\Big\}$ $P_{H\,(MAX)} = 30^{K}$

$\frac{49.5^2}{2} \times 0.0625 \times 28 = 2150^{K} \rightarrow$
$\frac{11.6^2}{2} \times .0625 \times 28 = \underline{118}$
2032^{K} $/2 = 1016 \approx 1000^{K}$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVERWALL STABILITY PILE LOADS	PROJECT L & D #1
	COMPUTED R.H.M. CHECKED JL	FILE NO. 800 A
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INTERCONNECTION OF MONOLITHS 19, 20 & 21 — NO BACKFILL

"LOCKSIDE AVERAGE" UPLIFT

ASSUME NO TRANSFER OF VERTICAL LOAD BETWEEN MONOLITHS

$\Sigma M_Y = \underline{78,200}'^K$ } (Fr. Foundation pressure)

5059	x 24.5	= 123945
5645	x −10.75	− 60684
4796	x −29.0	− 139084
$\Sigma V =$ 15500	$\bar{Y} =$ 4.89'	$\Sigma M_X =$ 75823

$\bar{X} = \frac{78200}{15500} = \underline{5.05}'$

$I_X = \underline{105,300}$ $\quad I_Y = \underline{13,500}$ $\quad \frac{M_X}{I_X} = 0.72$ $\quad \frac{M_Y}{I_Y} = 5.79$

$\frac{5059}{81} = 62^K$ $\quad \frac{5645}{81} = 70^K$ $\quad \frac{4796}{63} = 76^K$

$P_1 = 62 + .78(-36) + 5.79(-12)$
$\quad = 62 - 27 - 69$
$\quad = \underline{-34}^K$

$P_2 = 62 + .72(-12) + 69 = 122^K$

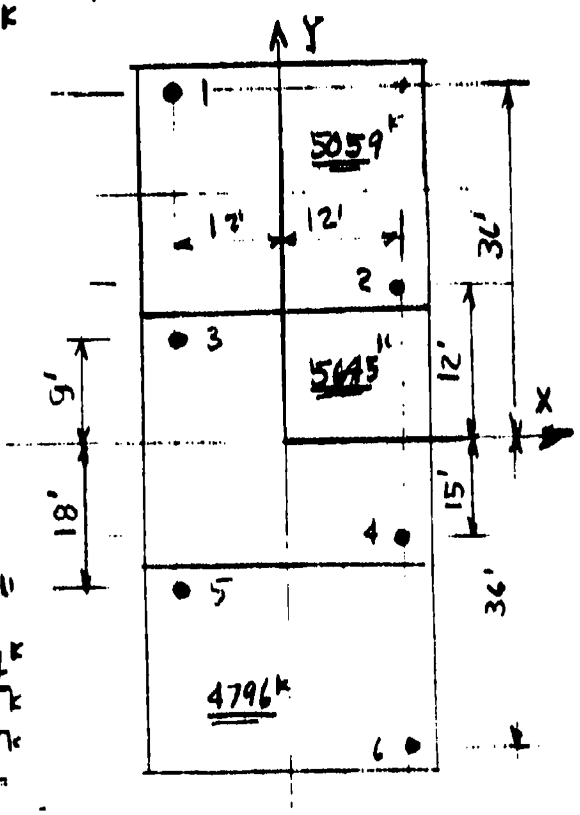
$P_3 = 70 + .72(-9) - 69 = -6^K$

$P_4 = 70 + .78(15) + 69 = 150^K$

$P_5 = 76 + .78(+18) - 69 = 20^K$

$P_6 = 76 + .72(36) + 69 = 172^K$

	P_{MAX}	M_{MIN}
MONOLITH # 19	122^k	-34^k
20	150^k	-6^k
21	172	20^k



FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVERWALL STABILITY PILE LOADS COMPUTED R.N.M. CHECKED JI	PROJECT L & D #1 FILE NO. 800 A DATE 4/'75 PAGE 106 E OF ___ PAGES

INTERCONNECTION OF MONOLITHS 19, 20 & 21 – NO BACKFILL

"LOCKSIDE MAXIMUM" UPLIFT

NO TRANSFER OF VERTICAL LOAD BETWEEN MONOLITHS

$$4531 \times 24.5 = 111{,}000$$
$$5380 \times -11.45 = -61{,}601$$
$$4796 \times -29 = -139084$$
$$\Sigma V = 15500 \qquad \bar{y} = 5.79 \qquad \Sigma M_x = 89685$$

$$\bar{x} = \frac{M_Y}{15500} = \frac{82{,}331}{15500} = 5.31'$$

$$\frac{M_X}{I_X} = 0.85 \qquad \frac{M_Y}{I_Y} = 6.10$$

$$\frac{4531}{81} = 56^K \qquad \frac{5380}{81} = 66^K \qquad \frac{4796}{63} = 76^K$$

MONOLITH # 19

$$P_{MIN} = P_1 = 56 + (.85)(-36) + 6.10(-12) = 56 - 30 - 73 = -47^K$$

$$P_{MAX} = P_2 = 56 + (.85)(-17) + 73 = 119^K$$

MONOLITH # 20

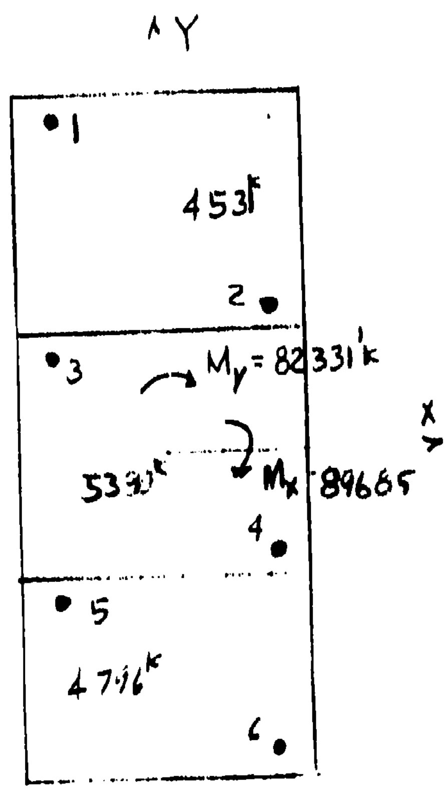
$$P_{MIN} = P_3 = 66 + (.85)(-9) - 73 = -14^K$$

$$P_{MAX} = P_4 = 66 + .85(15) + 73 = 151^K$$

MONOLITH # 21

$$P_{MIN} = P_5 = 76 + (.85)(18) - 73 = 18^K$$

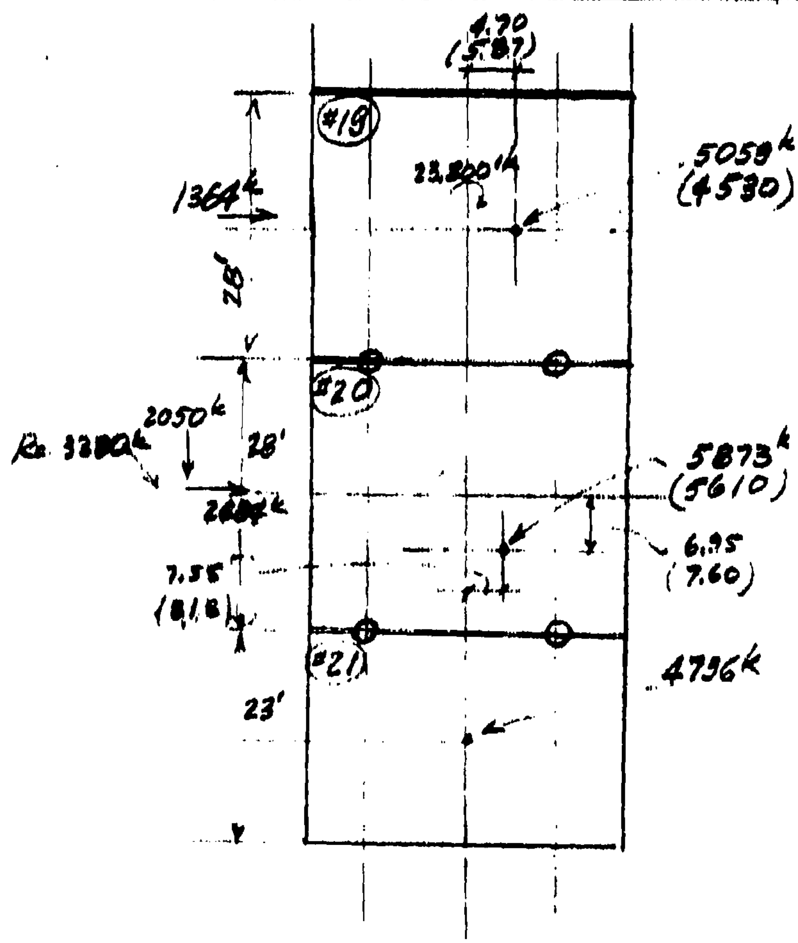
$$P_{MAX} = P_6 = 76 + 30 + 73 = 179^K$$



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVED CONDITIONS OF STABILITY C RIVER WALL	PROJECT L&D #1
	COMPUTED M.J. CHECKED	FILE NO. 800A
		DATE 1.75 PAGE 107 OF PAGES

RIVER WALL GATE MONOLITH #20 (CONT'ED)

INTERCONNECTION OF MONOLITHS #19, 20 & 21 & BACKFILLING



HARZA ENGINEERING COMPANY CHICAGO	SUBJECT IMPROVED CONDITIONS OF STABILITY & RIVER WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT LED #1 FILE No 800A DATE 1/75 PAGE 108 OF ___ PAGES

RIVER WALL GATE MONOLITH #20 (CONT'ED)

INTERCONNECTION OF MONO'S #19, 20, 21 & BACKFILLING

LOCKSIDE AVERAGE

5059	23,800
5873	44,420
4796	0.0
15,728 k	68,220

$X = \frac{68220}{15728} = 4.33 = e_x$

$\frac{5059}{812} \pm \frac{5059 \times 4.33}{3940} = 6.3 \pm 5.6$

11.9 max

$FSS = \frac{(5873+4796).55}{3380} = 1.74$

$S = \frac{28 \times 29^2}{6} = 3940$ ft³

$f_{SOIL} = \frac{5873}{812} \pm \frac{5873 \times 4.33}{3940} = 7.2 \pm 6.5 \begin{cases} MAX & 13.7 \text{ ksf} \\ MIN & 0.7 \text{ ksf} \end{cases}$

LOCKSIDE MAXIMUM

4530	26,600 ᵏ
5610	45,840 ᵏ
4796	0.0
14936	72,440 k

$X = \frac{72,440}{14936} = 4.84 = e_x$

11.14 ksf

$FSS = \frac{5610+4796}{3360} \times .55 = 1.70$

$\frac{4530}{812} \pm \frac{4530 \times 4.84}{3940} = 5.58 \pm 5.56$ ksf

$f_{SOIL} = \frac{5610}{812} \pm \frac{5610 \times 4.84}{3940} = 6.9 \pm 6.9 \begin{cases} MAX & 13.8 \text{ ksf} \\ MIN & 0.0 \text{ ksf} \end{cases}$

(NEXT Pp 108a TO 108e)

11

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY PILE LOAD	PROJECT L&D #1
	COMPUTED JI CHECKED R.N.H.	FILE NO. 800A
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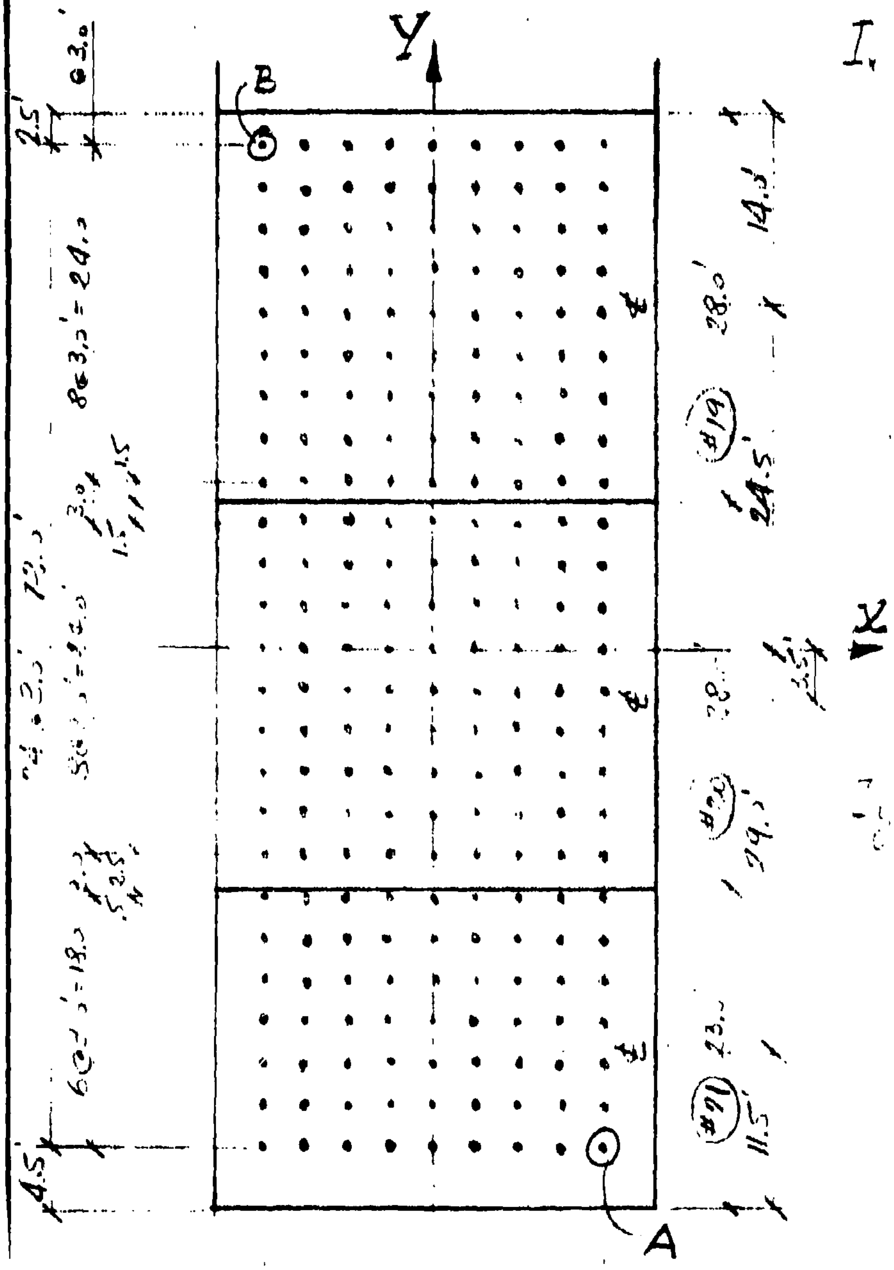
RIVER WALL MONOLITHS #19, #20 & #21 INTERCONNECTED
RIVERSIDE BACKFILLED UP TO EL. 710.0'



$I_x = 2 \cdot 9 \cdot 26.5^2$
23.5^2
20.5^2
17.5^2
24.5^2
21.5^2
18.5^2
12^2
9.5^2
3.5^2

10530 pile-ft²

12500 pile-ft²

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY PILE LOAD	PROJECT L&D #1
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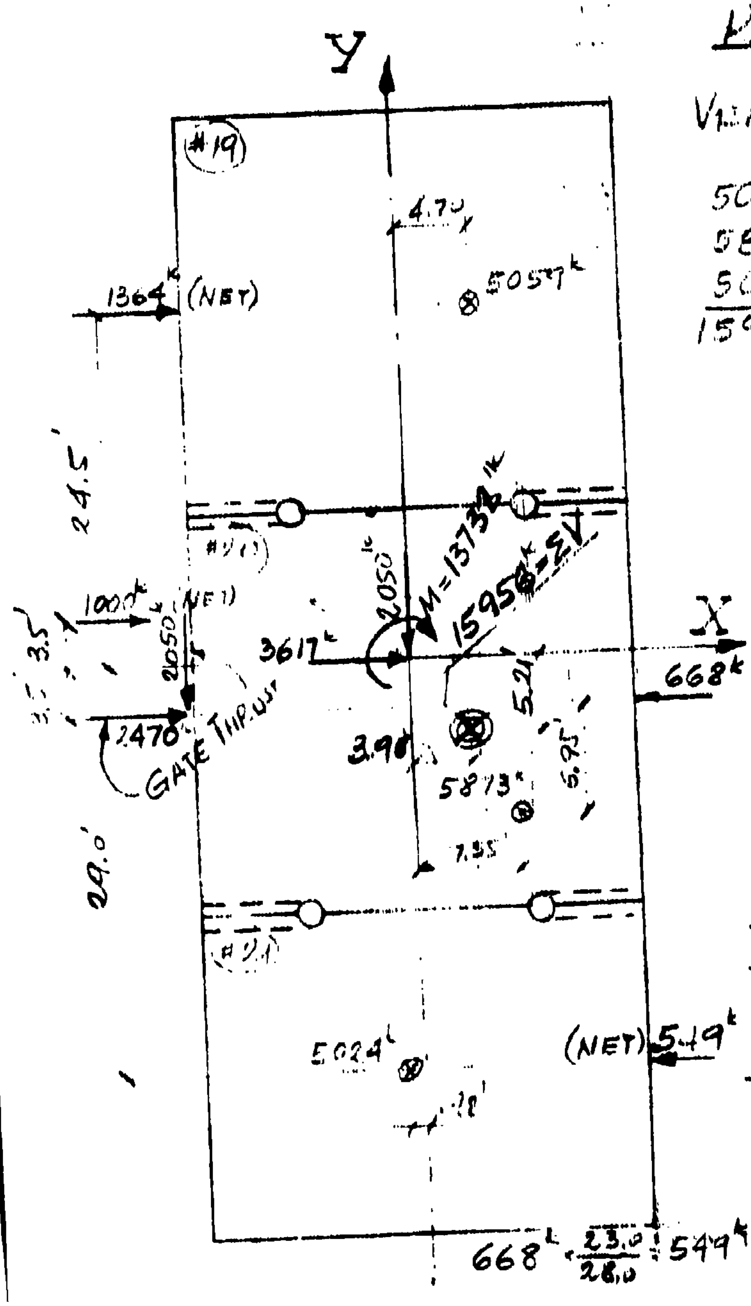
w/o perm. piles.

RIVERWALL MONOLITHS #19, #20 & #21 INTERCONNECTED

RIVERSIDE BACKFILLED UP TO El. 710.0'

"LOCKSIDE ANALYSIS" (REF. p. 96, 103 & 107)



RESULTANTS

VERTICAL

$5059 \times 4.70 = 23777$
$5873 \times 7.55 = 44341$
$5024 \times (-.92) = -4622$
$15956 \qquad 63496$

$\bar{X} = \frac{63496}{15956} = 3.98$

$5059 \times 24.5 = 12394$
$5873 \times (-5.95) = -34944$
$5024 \times -29.0 = -14570$
$15956 \qquad -83124$

$\bar{Y} = \frac{-83124}{15956} = -5.21'$

HORIZONTAL

$+1364 \times 24.5 = +33418$
$+1000 \times 3.5 = +3500$
$(2470-668) \times (-3.5) = -6307$
$-549 \times (-29.0) = +15921$
3617
$2050 \times (-16.0) = -32800$

$\Sigma M_H = +13732'^k$ (?)

(3)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY PILE LOAD	PROJECT ED #1
	COMPUTED JI CHECKED RNM	FILE NO 8004
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W/S pass prime

RIVERWALL MONOLITHS #19, #20 & #21 INTERCONNECTED
RIVERSIDE BACKFILLED UP TO EL.710.0'

"LOCKSIDE AVERAGE" (CONT'D)

$\Sigma V = 15956^k$

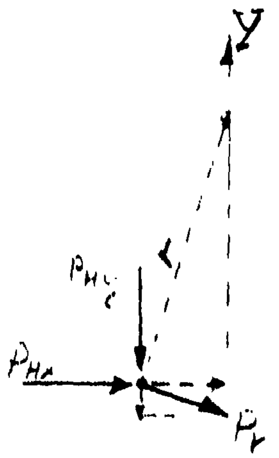
$\Sigma M_x = 83124^{1k}$ $\quad \Sigma M_y = 63496^{1k}$

$\Sigma H_x = \cancel{3380}\ 3617^k$ $\quad \Sigma H_y = 2050^k$ $\quad \Sigma M_H = \cancel{10596}\ 13732^{1k}$ (↻)

$$_AP_V = \frac{5024}{9\times7} + \frac{83124\times36.0}{105300} + \frac{63496\times12.0}{13500} = 80+28+56 = 164^k$$

$$_BP_V = \frac{5059}{9\times9} - \frac{83124\times36.0}{105300} - \frac{63496\times12.0}{13500} = 62-28-56 = -22^k$$

ASSUMING THAT ALL HORIZONTAL LOADS ARE TAKEN BY PILES (NO PASSIVE SOIL PRESSURE)!



$r = \sqrt{12.0^2 + 26.0^2} = 27.95'$

$I_p = I_x + I_y = 105300 + 13500 = 118800$

$P_{Hx} = \frac{3617}{[illegible]} = 16.07^k$ $\quad P_{Hy} = \frac{2050}{[illegible]} = [illegible]$

$P_r = \frac{13732 \times 27.95}{118800} = 4.38^k$

$P_{rx} = 4.38 \frac{[illegible]}{27.95} = 4.15^k$

$P_{ry} = 4.38 \frac{12.0}{27.95} = 1.38$

max $P_H = \sqrt{(P_{Hx}+P_{rx})^2 + (P_{Hy}+P_{ry})^2} = \sqrt{(16.07+4.15)^2 + (9.11+1.38)^2} =$

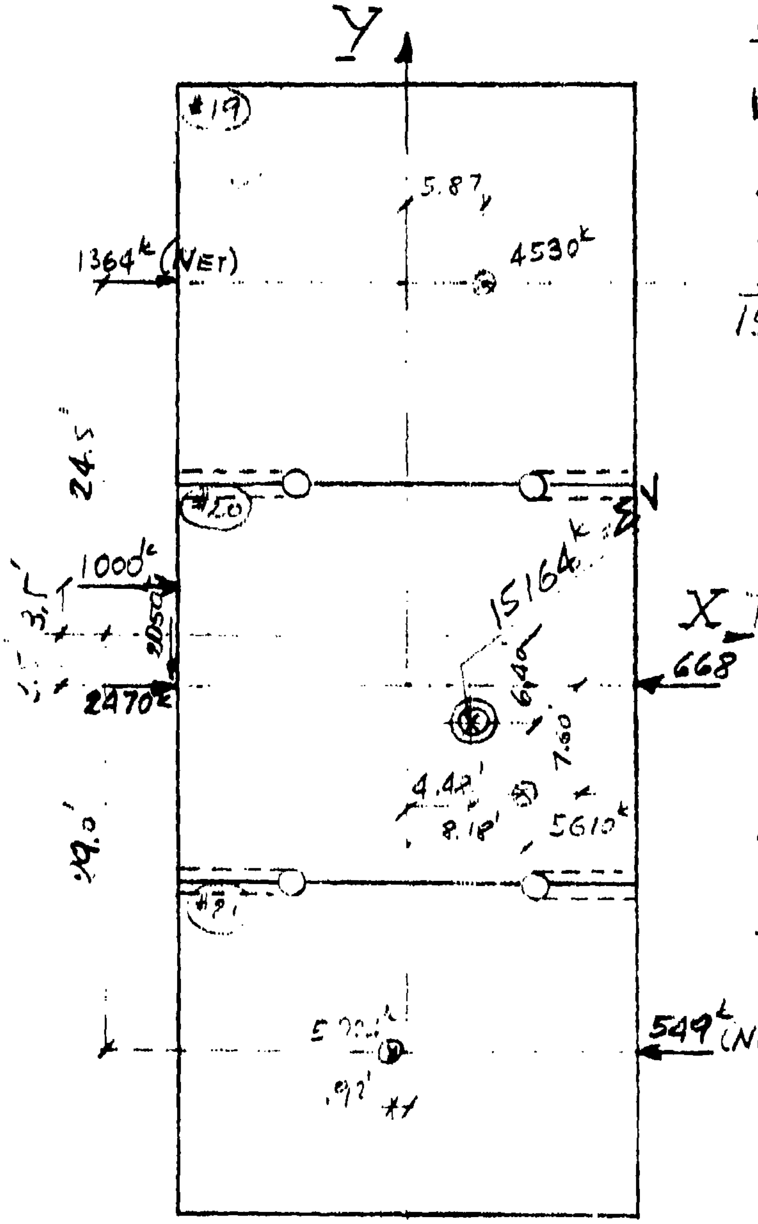
min $P_H = 14.21^k$ $\quad$ AVE. $P_H = 18.50^k$ $\quad = 22.78^k$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVER WALL STABILITY PILE LOAD	PROJECT L&D #1
	COMPUTED JJ CHECKED R.N.M.	FILE No. 800A
		DATE 3/75 PAGE 108d OF ___ PAGES

RIVER WALL MONOLITHS #19, #20 & #21 INTERCONNECTED.
RIVERSIDE BACKFILLED UP TO EL. 710.0'

"LOCK SIDE MAXIMUM" (REF. p. 97, 106 & 107)



RESULTANTS

VERTICAL:

4520 × 5.87 = 26[illegible]
5610 × 8.18 = [illegible]
5024 × (-.92) = -4622
15164   67859

$\bar{X} = \frac{67859}{15164} = 4.48'$

4530 × 24.5 = 110985
5610 × (-11.10) = -62271
5024 × (-29.0) = -145696
15164   -96982

$\bar{y} = \frac{-96982}{15164} = 6.40$

HORIZONTAL:

SAME AS [illegible]

W/O LEAS. piles

(5'

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RIVERWALL STABILITY PILE LOAD COMPUTED JI CHECKED R.N.M.	PROJECT L & D #1 FILE NO. 800A DATE 3/75 PAGE 108 e OF PAGES

RIVER WALL MONOLITHS #19, #20 & #21 INTERCONNECTED
RIVERSIDE BACKFILLED UP TO EL 710.0'

"LOCKSIDE MAXIMUM" CONT'D

$\Sigma V = 15164^{k}$

$\Sigma M_x = 96982^{'k}$ $\Sigma M_y = 67859^{'k}$

ΣH – SAME AS "LOCKSIDE AVERAGE"

$${}_{A}P_V = \frac{5024}{9\times7} + \frac{96982\times36.0}{105300} + \frac{67859\times12.0}{13500} = 80+33+60 = 173^{k}$$

$${}_{B}P_V = \frac{4530}{9\times9} - \frac{96982\times36.0}{105300} - \frac{67859\times12.0}{13500} = 56-33-60 = -37^{k}$$

$$P_H = \left\{\begin{matrix} 22.78^{k} \text{ max.} \\ 18.50^{k} \text{ ave.} \\ 14.21^{k} \text{ min.} \end{matrix}\right\} \text{same as Lockside Average}$$

W/S ... DATA

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT EXISTING CONDITION OF STABILITY @ RIVER WALL COMPUTED M.J. CHECKED R.N.M.	PROJECT LSD #1 FILE NO. 800 A DATE 1.75 PAGE 109 OF ___ PAGES

PILE BEARING CAPACITY

ULTIMATE BEARING CAPACITY (EM 1110-2-2906)

$Q_u' = A_t \gamma_2 D_2 N_q + \frac{1}{2} A_f K D_2^2 \gamma_2 \tan\delta$

$A_t = .785 \times .83^2 = .558\ FT^2$

$\gamma_2 = .034\ ^{Ton}/_{cu\,ft}$ PILE LENGTH ASS'D 13'

$D_2 = 13'$; $N_q = 20$

$A_f = \pi \times .83 = 2.6\ ft^2$

$K = 1.50$

$\tan\delta = \tan 33° = .65$

$Q_u' = .558 \times .034 \times 13 \times 20 + 1.3 \times 1.50 \times 169 \times .034 \times .65$

$Q_u' = 4.9 + 7.3$ = 12.2 TON/PILE

ASSUMING FS = 3

$Q = 12.2/3 = 4.0\ ^{TON}/_{PILE}$

PILE BEARING CAPACITY $Q = 8.0^k/_{PILE}$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY ANALYSIS OF DAM - LOADING CONDITIONS COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM #1 FILE NO. 800 A DATE JAN '75 PAGE 110 OF ___ PAGES

LOADING CONDITIONS - THE FOLLOWING ARE ASSUMPTIONS AND OTHER GIVEN DATA USED IN THE ANALYSES OF VARIOUS LOADING CONDITIONS. IN ALL CASES, THE HORIZONTAL PILE LOAD OF 4K PER PILE AND FRICTIONAL RESISTANCE OF 40'± APRON DUE TO ITS SUBMERGED WEIGHT ARE ASSUMED TO RESIST HORIZONTAL FORCES.

I NORMAL OPERATING CONDITION

1. UPSTREAM WATER SURFACE EL. 723.2
2. EXISTING SAND FILL IN DAM
3. UPSTREAM SEDIMENT EL 710±
4. TAILWATER ELEVATION 690.6'
5. ICE PRESSURE 10 KIPS PER FOOT OF CREST HORIZONTAL AT ELEVATION 723.2'
6. TENDENCY OF MONOLITH TO SLIDE TAKEN ALONG CRITICAL PLANE FROM BOTTOM OF CUT-OFF WALL, EL 684.6 TO EL. 690.6 AT THE TOE. (FOR ALL LOADING CONDITIONS)

II FLOOD DISCHARGE CONDITION

A. 1965 FLOOD EXISTING CONDITION

1. MAX. UPSTREAM W.S. EL 734.7
   TAIL WATER AND LOWER POOL EL 719.
2. SPACE INSIDE OF DAM FILLED WITH WATER
3. UPLIFT DETERMINED BY FLOW NET METHOD.

B. 1951 FLOOD EXISTING CONDITION

1. MAX. UPSTREAM W.S. EL. 731
   TAILWATER EL. 695.5 (BEFORE HYDRAULIC JUMP)
   LOWER POOL EL. 709.0
2. UPLIFT DETERMINED BY FLOW NET METHOD.
3. WATER INSIDE DAM SAME LEVEL AS RELIEF HOLE OUTLETS (EL 697.4±)

LOADING CONDITIONS (CONT'D)

III EARTHQUAKE CONDITION

1. EARTHQUAKE INERTIA FORCES AND HYDRO-DYNAMIC FORCES ADDED TO AND ICE PRESSURE REMOVED FROM NORMAL OPERATING CONDITION.

2 EARTHQUAKE ACCELERATION ASSUMED TOWARD UPSTREAM DIRECTION I.E., FORCES ARE OPPOSITE (TOWARD DOWNSTREAM DIRECTION).

$\alpha/g = 0.1$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY ANALYSIS OF DAM - IMPROVED CONDITION COMPUTED R.N.M. CHECKED JI	PROJECT LOCK & DAM #1 FILE NO. 800 A DATE JAN. '75 PAGE 112 OF ___ PAGES

LOADING CONDITION

1951 FLOOD IMPROVED CONDITION

1. MAXIMUM UPSTREAM W. S. EL 731
   TAILWATER EL. 695.5
   LOWER POOL EL 709.

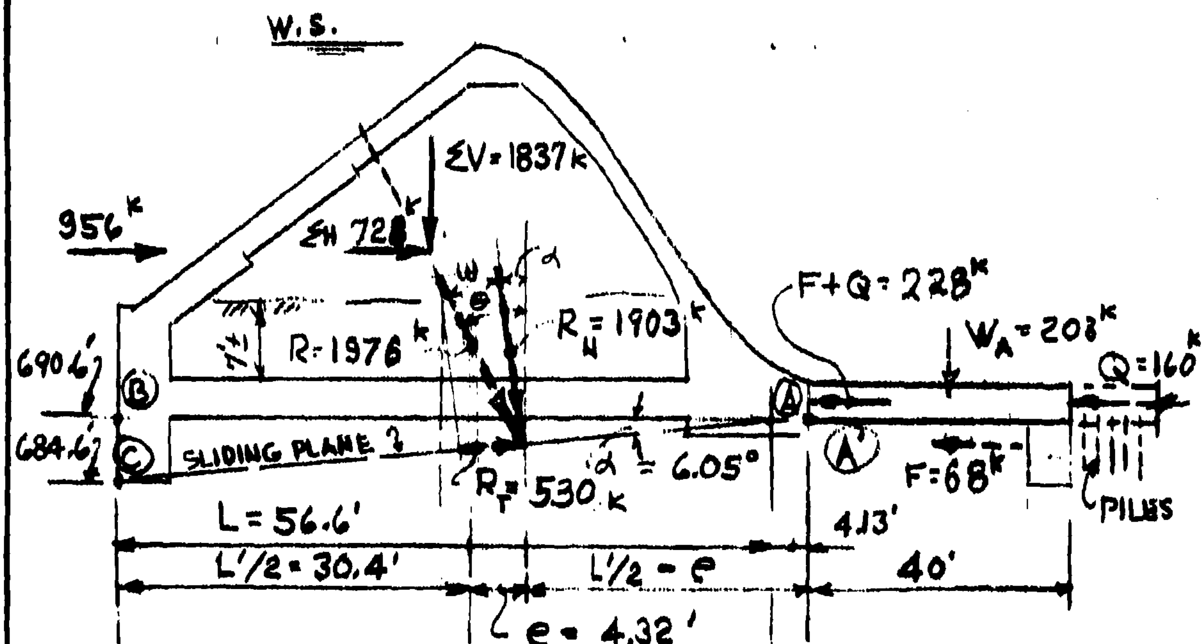
2. UPLIFT DETERMINED BY FLOW NET METHOD

3. WATER IN CAVITY OF DAM SAME LEVEL AS RELIEF HOLE OUTLETS (EL. 697.4±)

4. FOR STABILIZATION BY INCREASING THE HEIGHT OF EXISTING SAND FILL, A SLIDING SAFETY FACTOR OF 1.5 WAS SET FOR THE FORCE OF FRICTION TO EQUALIZE THE COMBINED TANGENTIAL COMPONENTS OF ΣV & ΣH FORCES ON AN INCLINED SLIDING PLANE, AND THE REQUIRED HEIGHT OF ADDITIONAL SAND FILL DETERMINED.

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RESULTS OF BUTTRESS DAM STABILITY ANALYSIS COMPUTED R.N.M. CHECKED JI	PROJECT LOCK & DAM #1 FILE NO. 800 A DATE JAN '75 PAGE 113 OF ___ PAGES

I NORMAL OPERATING CONDITION (EXISTING)



1. BEARING PRESSURES $f_{A'}$ = ~~2.24~~ 2.53 KSF

   f_B = 1.08 (2) KSF

2. RESULTANT WITHIN MIDDLE $\frac{1}{3}$, e = ~~4.08~~ 4.32'

3. SLIDING FACTOR, $\frac{R_T}{R_N} = 0.279$

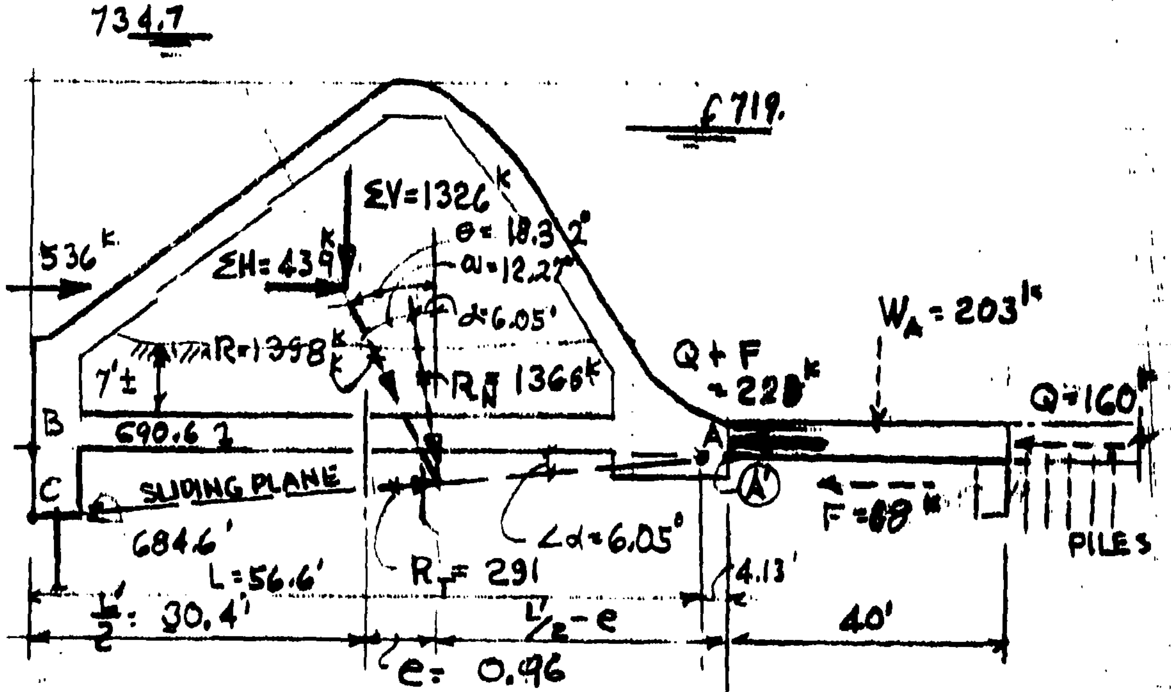
4. "SLIDING SAFETY FACTOR", SSF = 2.33
   (f 0.649)

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RESULTS OF BUTTRESS DAM STABILITY ANALYSIS COMPUTED RNM CHECKED JJ	PROJECT LOCK AND DAM No. 1 FILE No. POD A DATE JAN '75 PAGE 114 OF ___ PAGES

II FLOOD DISCHARGE CONDITION

A. 1965 FLOOD EXISTING CONDITION



1. BEARING PRESSURES: $f_{A'} = \cancel{1.19}$ 1.36 KSF

   $f_B = \cancel{1.12}$ 1.13 KSF

2. RESULTANT WITHIN MIDDLE $\frac{1}{3}$; $e = \cancel{0.32}$ 0.96

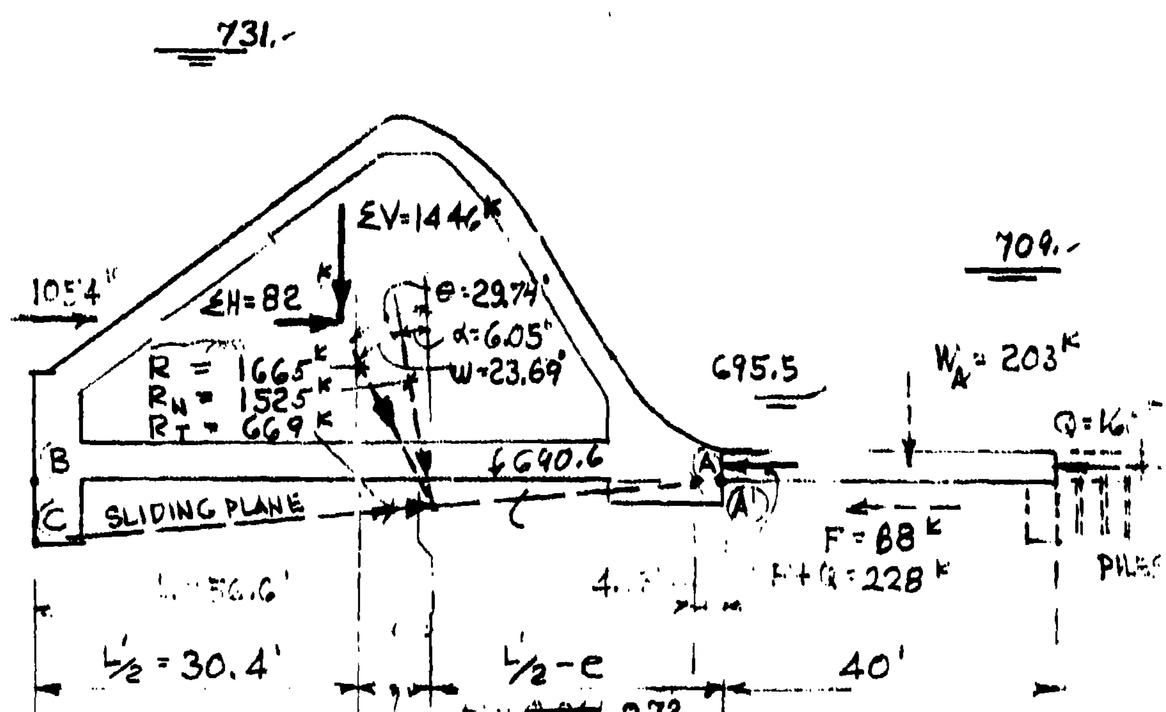
3. SLIDING FACTOR, $\frac{R_T}{R_N} = 0.217$

4. SLIDING SAFETY FACTOR, SSF 2.98
   $(f = 0.649)$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RESULTS OF BUTTRESS DAM STABILITY ANALYSIS COMPUTED R.N.M. CHECKED JI	PROJECT LOCK & DAM No 1 FILE No 800 A DATE JAN '75 PAGE 115 OF ___ PAGES

II FLOOD DISCHARGE CONDITION

B. 1951' FLOOD EXISTING CONDITION



1. BEARING PRESSURES: $f_{A'}$ ~~1.31~~ 1.47 KSF

   $f_{(B)}$ = ~~1.24~~ 1.27 KSF

2. RESULTANT WITHIN MIDDLE $\frac{1}{3}$. e = ~~4.26~~ 0.72

3. SLIDING FACTOR $\frac{R_T}{R_N} = 0.439$

4. SLIDING SAFETY FACTOR, SSF = 1.48
   (f · 0.649)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RESULTS OF BUTTRESS DAM STABILITY ANALYSIS	PROJECT LOCK & DAM #1
	COMPUTED R.N.M. CHECKED JI	FILE No. 800 A
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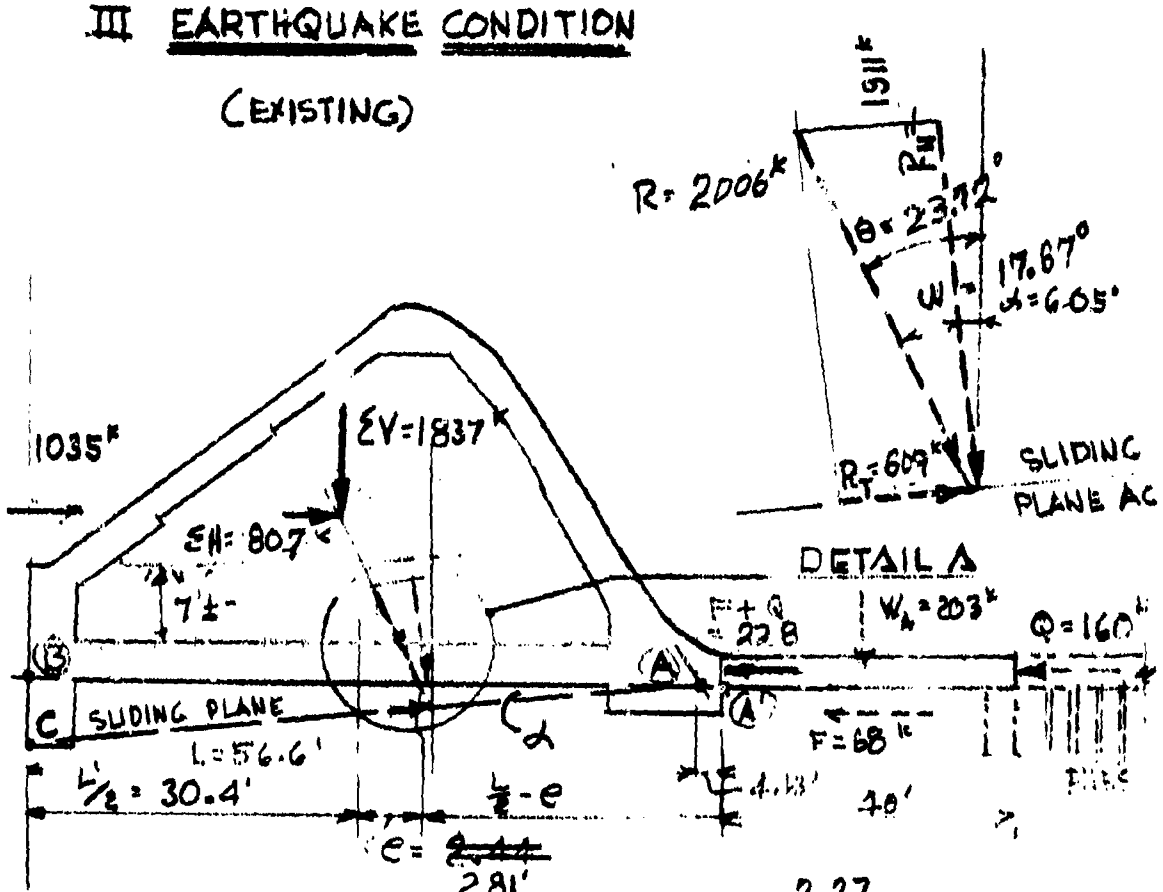
III EARTHQUAKE CONDITION

(EXISTING)



1. BEARING PRESSURES $f_{A'} = \cancel{2.08}\ 2.27$ KSF

   $f_B = 1.28$ KSF

2. RESULTANT WITHIN MIDDLE 1/3, $e = \cancel{2.44}\ 2.81'$

3. SLIDING FACTOR, $\frac{R_T}{R_N} = .0.319$

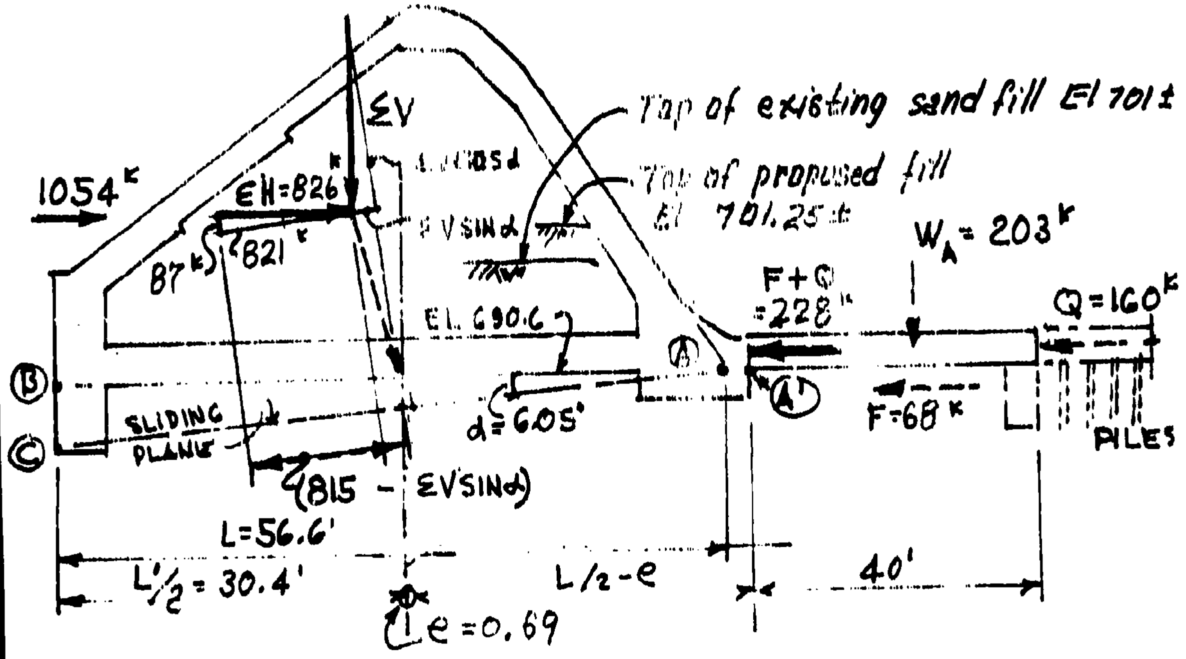
4. SLIDING SAFETY FACTOR, SSF = 2.03
   ($f = 0.649$)

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT RESULTS OF BUTTRESS DAM STABILITY ANALYSIS COMPUTED R.N.M. CHECKED JJ	PROJECT LOCK & DAM #1 FILE NO. 800A DATE 4/'75 PAGE 117 OF ___ PAGES

FLOOD DISCHARGE

1951 FLOOD - IMPROVED CONDITION



$$\left(87 + \Sigma V \cos 6.05^\circ\right)\frac{.649}{1.5} = 821 - \Sigma V \sin 6.05^\circ$$

$\Sigma V = 1463^K$ IMPROVED

$\Sigma V' = -1446$ WITHOUT IMPROVEMENT

$\Delta V = 17^K$ REQUIRED WEIGHT OF ADDITIONAL SAND FILL FOR SSF OF 1.5

1. BEARING PRESSURES:
2. RESULTANT WITHIN MIDDLE THIRD $e = 0.69$
3. SLIDING FACTOR = 0.6
4. SSF = 1.5

$= 1.48$ ksf

$= 1.30$ ksf

R.N

NORMAL
OPERATING CONDITION

ASSUMPTIONS:

B. A =16'

1. UPSTREAM WATER SURFACE ELEV. 723.2' - 56.6

2. EXISTING SAND FILL 7' HIGH

3. UPSTREAM SEDIMENT HEIGHT 15'

4. TAILWATER ELEV. 690.6'

5. 8" TO 12" CONCRETE RESURFACING @ DOWNSTREAM FACE.

7. 2' OF ICE = 10^K PER FOOT OF CREST →

(PAGE 5 OF EM 1110-2-2200)

1. 2.75 x 8.75 x 1
2. 2.5 x 12.53 x 1
3. 2.17 x 13.3 x 1
4. 3.5 x 6.2 x ½ x
5. ⅔ x 12.51 x 11.02 x
6. 1.5 x 16.0 x 16
7. 5.9 x 4 x ½ x 16
8. 5.9 x 3.8 x 16
9. 46.9 x 3.0 x 16
10. 10.0 x 4.0 x 16
11. 1.0 x 1.5 x (16 -
12. 6.0 x 1.0 x 0.
13. 5.0 x 1.0 x 0.
14. 8.54 x 42.4
15. 1.7 x 3.5 x 4
16. 2.75 x 3.9 x 4
17. 1.0 x 1.5 (16 -
18. 1.0 x 1.5 (16 -
19. 0.5 x 42.4 x
20. 6.25 x 4.7 x ½
21. 2.7 x 4.7 x ½
22. 33.7 x 4.7 x
23. 1.0 x 1.5 x (16 -
24. 1.0 x 6.0 x 3.
25. 1.0 x 1.5 (16 -

R.N.M. 8/14 J1 3/24/75 118

690.6 (M.S.L.)

		(KIPS)		(FEET)		(FT-KIPS)
1.	2.75 × 8.[illegible] × 16 × 0.15	57.95		49.8		2886
2	2.5 × 12.58 × 16 × 0.15	75.48		41.2		3110
3	2.11 × 13.[illegible] × 16 × 0.15	69.42		31.4		2180
4	3.5 × [illegible] × ½ × 16 × 0.15	9.24		25.5		236
5	⅔ × 12.51 × 11.02 × 16 × 0.15	220.57		20.0		4411
6	1.5 × 16.[illegible] × 16 × 0.15	58.32		9.5		554
7	5.9 × 4 × ½ × 16 × 0.15	28.32		4.1		116
8	5.9 × 3.8 × 16 × 0.15	53.31		2.9		156
9	46.8 × 3.0 × 16 × 0.15	337.00		29.2		9839
10	10.0 × 4.[illegible] × 16 × 0.15	96.00		54.6		5242
11	1.0 × 1.5 × (16−2) 0.15	3.15		19.7		59
12	6.0 × 1.0 × 0.33 × 0.15		0.30	18.4	6	
13	5.0 × 1.0 × 0.33 × 0.15		0.25	38.0	10	
14	8.[illegible]4 × 42.4 × 0.15	56.22		28.6		1608
15	1.7 × 3.5 × 4.[illegible] × 0.15	3.57		6.5		23
16	2.75 × 3.9 × 4.[illegible] × 0.15	6.44		51.0		328
17	1.0 × 1.5 (16−2.2) × 0.15	3.11		26.7		83
18	1.0 × 1.5 (16−2.2) 0.15	3.11		34.3		106
19	0.5 × 42.4 × 2.2 × 0.15	7.00		28.5		200
20	6.25 × 4.7 × ½ × 2.2 × 0.15	4.85		45.7		222
21	2.7 × 4.7 × ½ × 2.2 × 0.15	2.09		9.1		19
22	33.7 × 4.7 × 2.2 × 0.15	52.27		26.8		1401
23	1.0 × 1.5 × (16−2) 0.15	3.15		29.2		92
24	1.0 × 6.0 × [illegible] × 0.15		0.30	28.3	8	
25	1.0 × 1.5 (16−1.7) 0.15	3.20		23.0		74
	Sub-total 1	1154.27	0.85		24	32945

LOCK & DAM #1
STABILITY OF DAM

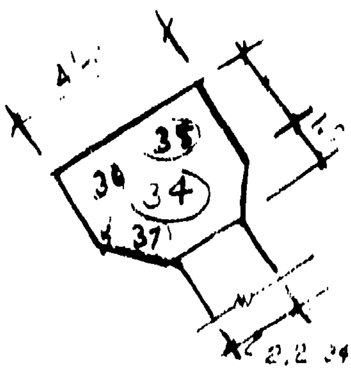
2

1

K.N.

NORMAL CONDITION (CONT'D)

A



2.0' for 34
1.75 for 35
1.67' for 36
1.10 for 37

Areas:

$4 \times 2 = 8.00$

$\frac{4+2.2}{2} = 3.10$

$A_{34} = 11.10$

2.2 34
1.8 35
1.5 36
1.5 37

$4 \times 1.75 = 7.0$

$\frac{4+1.8}{2} = 2.9$

$A_{35} = 9.9$

$4 \times 1.67 = 6.68$

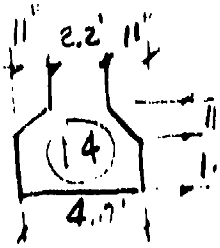
$\frac{4+1.5}{2} = 2.75$

$A_{36} = 9.43$

$4 \times 1.10 = 4.4$

$\frac{4+1.5}{2} = 2.75$

$A_{37} = 7.15$



$4 \times 1.5 = 6$

$\frac{2.2+4}{2} \times \frac{11}{12} = 2.84$

$A_{14} = 8.84\ ft^2$

-5a 4.0 × 3.0 × 16 ×
-5b 0.5 × 7.0 × 16 ×
-5c 4.0 × 6.0 × ½ × 1
10a 1.5 × ½ × 1
26 1.0 × 1.5 × 16
27 10.5 × 8 × ½ × 1.
28 4.4 × 3 × ½ × 1.
29 19.3 × 3 × 1.
30 9.7 × 7.3 × ½ ×
31 3.8 × 7.8 × 1.
32 6.0 × 7.8 × 1.
33 3.0 × 6.0 × 1.
34 11.1 × 8.5 ×
35 9.9 × 12.5"
36 9.43 × 13.33 ×
37 7.15 × 4.0 ×
38 5.75 × 8. ×
39 8.15 × 6.4 ×
40, 41 } 1.0 × 14.6 ×

1

184

KNM 9/74 JI 3/24/75 119

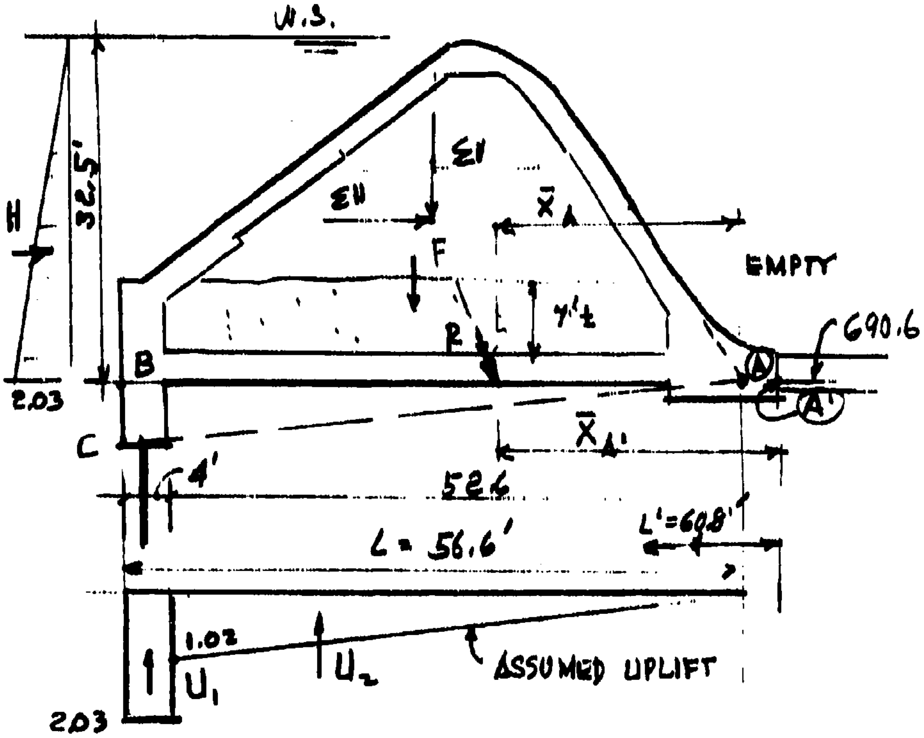
236.6 CM.S.

4.0 x 3.0 x 16 x 0.15		76.80	22.7	1743		Reduction in Parabolic Area
2.5 x 7.0 x 16 x 0.15		4.30	31.5	819		
4.0 x [illegible] x 16 x 0.15		[illegible]	17.0	430		
1.5 x [illegible] x 16 x 0.15		3.60	53.2	192		— Item Reduction
[illegible] x 16 [illegible] x 0.15	[illegible]		19.4		[illegible]	— Beam
[illegible] x 0.15	[illegible]		37.4		431	
4.4 x [illegible] x 0.15	4.[illegible]		13.3		64	
[illegible] x 0.15	4.[illegible]		24.3		1030	
9.7 x 2.5 x ½ x [illegible] x 0.15	[illegible].51		27.8		237	
3.5 x 7.5 x 7.5 x 0.15	[illegible]		22.8		152	
[illegible] x 7.5 x 7.5 x 0.15	10.53		18.6		196	
[illegible] x [illegible] x 0.15		4.05	21.0	85		Wall opening
11.1 x [illegible] x 0.15	14.15		48.0		679	
[illegible]9 x [illegible] x 0.15	18.6[illegible]		40.6		747	
[illegible] x 0.15	[illegible]		29.[illegible]		558	
2.15 x [illegible] x 0.15	4.[illegible]		[illegible]		37	
[illegible] x 0.15	[illegible]		18.[illegible]		191	
3.[illegible] x [illegible] x 0.15	4.4[illegible]		14.1		66	
[illegible] x 0.15	[illegible]		10.8		202	
Total 2	176.38	155.[illegible]		3379	4712	~~[illegible]~~ 32945
Total 1	[illegible]	[illegible]		[illegible]4		~~[illegible]~~ 37657
	1[illegible]	156.10		[illegible]		~~[illegible]~~ 34304
sub total	1176.55		29.10			
	≃1177[k]					

LOCK & DAM No 1

STABILITY OF DAM

NORMAL CONDITION (CONT'D)



42 15.8
43 5.5
44 9.0 x
45 6.0 x

F 45 x
Sail

Water
H .0625
W_1 22.2
W_2 22.2
U_1 32.5
U_2 32.5

Earth
fo
HS_{15} .020 x 5
WS_{15} 9.0 x

Ice
10 x

Conc.

BEARING PRESSURES:

$$\bar{X}_{A'} = \frac{\cancel{36190}\ 37885}{\cancel{1631}\ 1726} + 4.13 = \cancel{26.34}\ 26.08' \qquad e = 30.4 - \bar{X}_{A'} = \cancel{4.06}\ 4.32$$

$$f_{A'} = \frac{\cancel{1631}\ 1726}{972.8}\left(1 + \frac{6 \times \cancel{4.06}\ 4.32}{60.8}\right) = \cancel{2.34}\ 2.53$$

$$f_B = 1.677(1 - 0.\cancel{40}\ 42) = \cancel{1.00}\ 1.02$$

4.0 × 6.0 × 16 × .088 = 34 × 54.6 = -1045
2.0 × 10 × 16 × .088 = 28 × .87 = -25
3.3 × 4.13 × 16 × .15 = 33 × 2 = +67
Wt. of conc. below El 690.6 = 95^k -1803 'k

690.6 (M.S.L

42	15.8 x 1.0 x 16 x 0.15		37.92		7.8		296	Resurfacing
43	5.5 x 1.0 x 16 x 0.15		13.20		2.2		29	
44	9.0 x 0.83 x 16 x 0.15		17.93		14.6		262	
45	6.0 x 0.67 x 16 x 0.15		9.65		19.8		191	
		total 3	78.70				778	
F	4½ x 7 x 14 x 0.12 cement-sand fill		526.4		29.0		15266	7½ high fill
	Water:							
H	.0625 x 32.5² x 16 x ½	+528.13			10.83	5,720		Hydrostatic
W_1	22.23 x 29.33 x 16 x 0.0625/2		326.00		44.53		14517	Weight of Water
W_2	22.23 x 2.34 x 16 x 0.0625/2		52.02		55.48		2886	
U_1	32.5 x 0.0625 x 4 x 16			130.00	54.65	7105		
U_2	$\frac{32.5 \times 0.0625}{2}$ x 52.65 x 16 x ½			427.78	35.10	15015		
	Earth and sediment forces:							
HS_{15}	.020 x .5 x 15² x 16 x ½	+37			5.0	185		See Flood condition
WS_{15}	9.0 x 6.0 x ½ x 0.0615 x 16		29.0		53.65		1556	
	Ice pressure:							
	10 x 16	160			32.5	5200		
	sub-total 4 =	725.1	933.4	557.78		33225	~~33464~~ 34225	
	Conc. below el 690.6	=	95				1803	
		725.1	2439.8	713.9		36576	74462	
				1726			37885	

-1045
-25
+67
1803 k

(A) = ~~2.34~~ 2.53 KSF

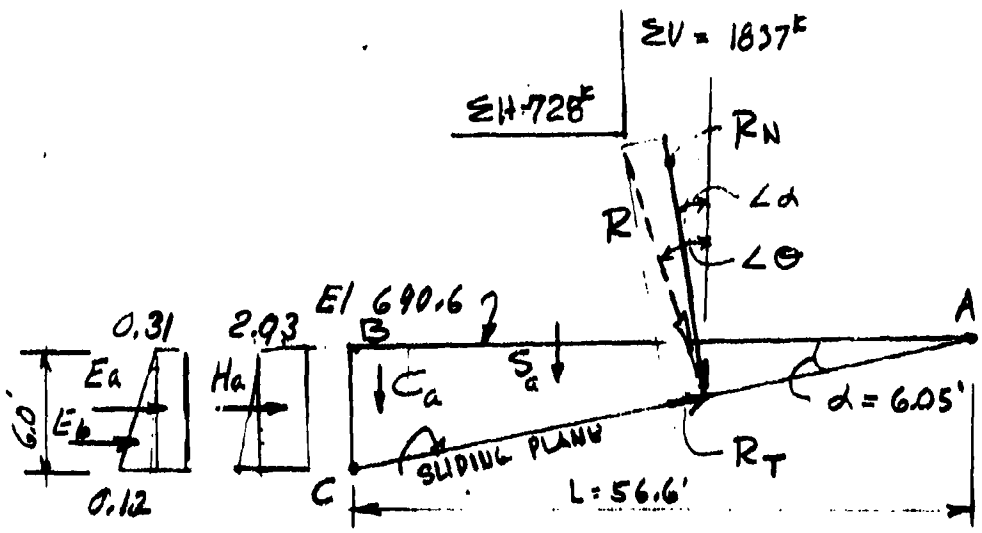
(B) = ~~1.00~~ 1.02 KSF

LOCK & DAM #1
STABILITY OF DAM

2

NORMAL OPERATING CONDITION
(CONT'D)

SLIDING SAFETY FACTOR (SSF)
ASSUME APRON SLAB & PILE
RESISTANCE AS IN Pg. 1254



$$R = \sqrt{728^2 + 1837^2} = 1976$$

$$\theta = \tan^{-1}\frac{728}{1837} = 21.62^\circ$$
$$- 6.05^\circ$$

$R_T = R \sin 15.57^\circ = \frac{530^k}{1903^k}$ = .279 SLIDING FACTOR =

$R_U = R \cos 15.57^\circ$

$$SSF = \frac{.649}{530/1903} = 2.33$$

Above E
Below

H_a 2.03 x 6

E_a 0.31 x 6

E_b $\frac{0.12 \times 6}{2}$

S_a 52.6 x 6

C_a 6 x 4

PILE RESI

APRON SUR
FRICTION
WITH 1.5
Cf =

R.N.M. 8/74 J1 3/24/75 121 .186

690.6 − 684.6

Above elev. 690.6 → + 725 1631

Below 690.6:

H_a 2.03 × 6 × 16 — 195

E_a 0.31 × 6 × 16 — + 30

E_b $\frac{0.12 \times 6 \times 16}{2}$ — + 6

$\Delta H = 231$

S_a $\frac{52.6 \times 6 \times 16 \times .068}{2}$ — 172

C_a 6 × 4 × 16 × 0.088 — 34

$\Delta V = 206$

PILE RESISTANCE −160

APRON SUBMERGED WT. FRICTION RESISTANCE WITH 1.5 SAFETY FACTOR (Cf = .499) − 68

Pg 125a

Pg 135

728^k

1837

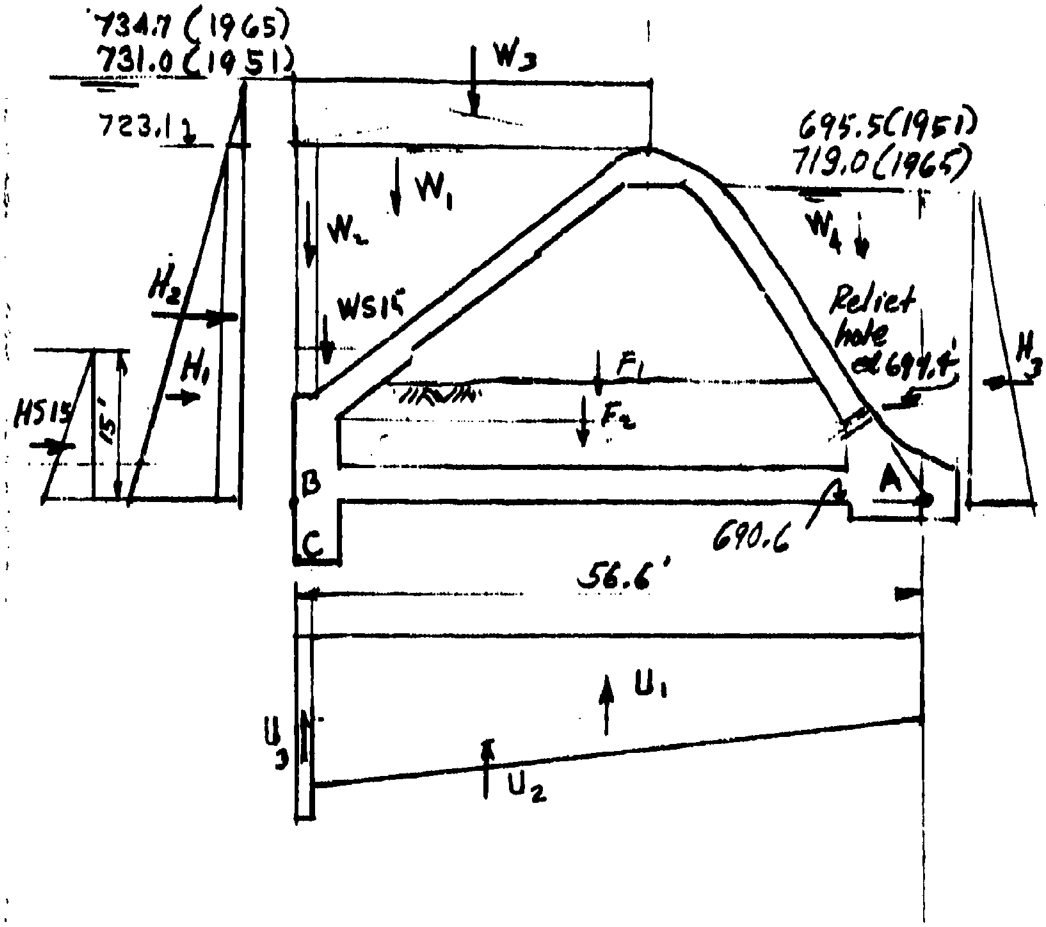
LOCK AND DAM #1

STABILITY OF DAM

2

FLOOD DISCHARGE CONDITION

APRIL 1951 FLOOD }
APRIL 1965 FLOOD } FORCES



W_1 22.23 x
W_2 22.23 x

W_3 (1965) 11.5
W_3 (1951) 7.8

H_1 0.0625 x 3
H_2 (1951) = 7.8
H_2 (1965) = 11.5 x

H_3 (1951) = 0.06
H_3 (1965) = 0.0

U_1 55.6 x 33
U_2 4.5 x 55
U_3 1.0 x 44
U_1 30.6 x 15
U_2 30.6 x 6.
U_3 25 x 22
U_4 25 x 3.6
U_5 1.0 x 40.
HS15 0.0205 x 1
WS15 9 x 6 x $\frac{1}{2}$ x
F_1 (1951) 44 x 3
F_1 (1965) 44 x 3
F_2 47 x 3.7 x

→④

W_1	22.23 x 29.33 x 1.0/2		326		44.5		14507	
W_2	22.23 x 2.34 x 1.0		52		55.5		2886	
W_3(1965)	11.5 x 31.7 x 1.0		365		40.7		14856	
W_3(1951)	7.8 x 31.7 x 1.0		247		40.7		10053	
H_1	$0.0625 \times 32.5^2 \times 16 \times \frac{1}{2}$	+528			10.8	5720		
H_2(1951)	= 7.8 x .0625 x 32.5 x 16	+254			16.3	4140		1951 Flood
H_2(1965)	= 11.5 x .0625 x 32.5 x 16	+374			16.3	6096		1965 Flood
H_3(1951)	$= 0.0625 \times 4.8^2 \times 16/2$	-12			1.6		19	
H_3(1965)	$= 0.0625 \times 28.4^2 \times 16/2$	-403			9.5		3820	
U_1	55.6 x 33.5 x 1.0 (1965)			1863	27.8	51791		uplift, 1965 Flood
U_2	4.5 x 55.6 x 1.0/2 (1965)			125	37.0	4625		
U_3	1.0 x 44.0 x 1.0 (1965)			44	56.1	2468		
U_1	30.6 x 15.5 x 16 x .0625			474	15.3	7252		Uplift, 1951 Flood, see uplift diagram
U_2	$30.6 \times 6.5 \times \frac{1}{2} \times 1.0$			99	20.4	2020		
U_3	25 x 22 x 1.0			550	43.1	23705		
U_4	$25 \times 3.6 \times \frac{1}{2} \times 1.0$			45	47.3	2129		
U_5	1.0 x 40.0 x 1.0			40	56.1	2244		
HS15	$0.0205 \times 15^2 \times 16 \times \frac{1}{2}$	+37			5.0	185		Sediment ω = 130, K = 0.3
WS15	$9 \times 6 \times \frac{1}{2} \times .0675 \times 16$		29		53.7		1556	
F_1(1951)	44 x 3.3 x 14 x 0.12		244		29.0		7076	Existing Sand fill
F_1(1965)	44 x 3.3 x 14 x 0.13		264		29		7656	
F_2	47 x 3.7 x 13 x 0.13		294		29		8526	

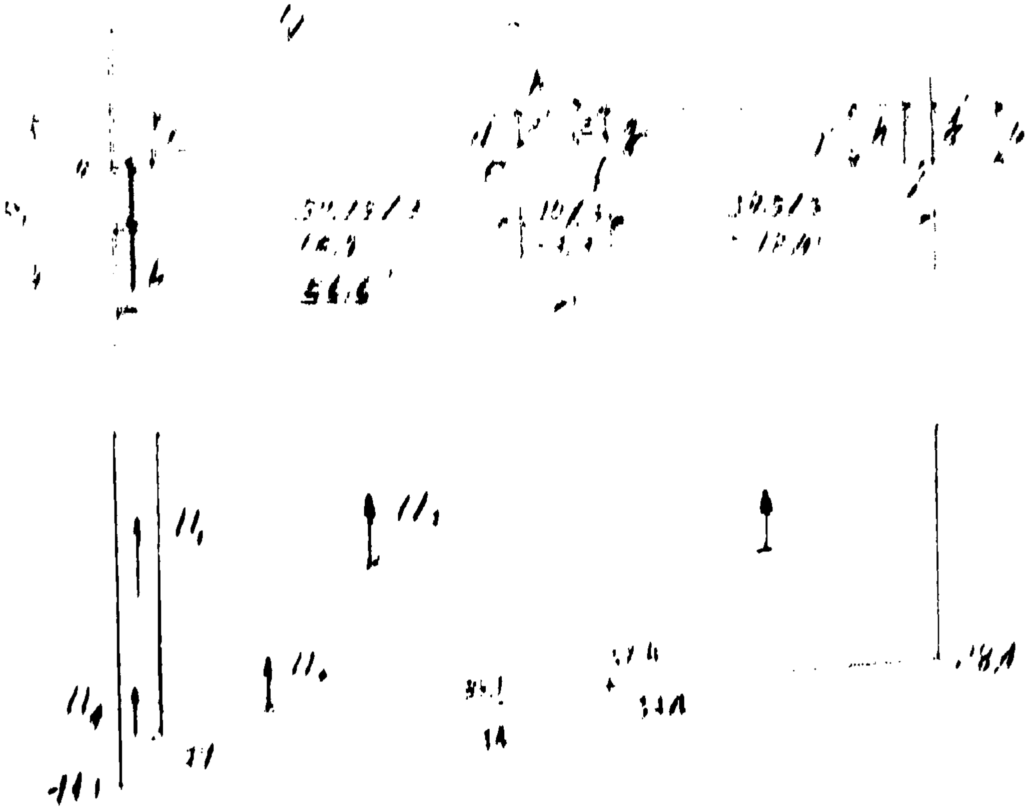
LOCK AND DAM NO. 1
STABILITY OF DAM

FLOOD DISCHARGE CONDITION

1965 FLOOD

Purpose

Determination of uplift using weighted creep theory for comparison with flow net method (Reference Design of Small Dams)



Point
a
b
c
d
e
f
g
h
i
j

U_1 37 x 4

U_2 3 x 12.6

U_3 3? x 52.

U_4 1.1 x 4

$H = 734.7 - 719 = 15.7'$
$L = 92 \quad r = \frac{L}{H} = 5.85$

Point	Creep length, x	Uplift, $(L-x)\frac{L}{r} + 28.4$
a	0	44.1
b	21.	40.5
c	42	36.9
d	58.9	34.0
e	60.9	33.7
f	64.2	33.2
g	66.2	32.8
h	79.0	30.6
i	86.0	29.4
j	92.0	28.4

U_1	37×4	148
U_2	$3 \times 52.6/2$	79
U_3	34×52.6	1788
U_4	$7.1 \times 4/2$	14

$\Sigma U = 2029$ kips creep theory

$\Sigma U = 2032$ kips Flow net method

$\therefore$ USE FLOW NET

LOCK AND DAM NO. 1
STABILITY OF DAM

2

R.

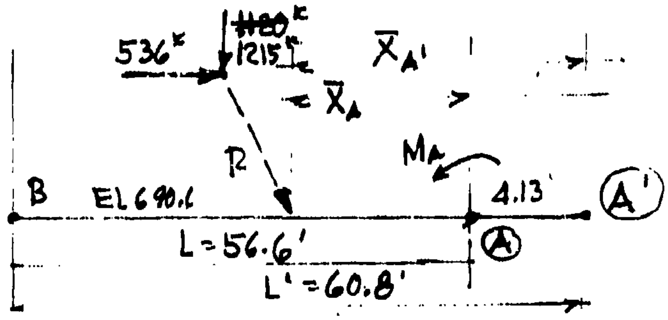
FLOOD DISCHARGE CONDITION

1965 FLOOD

Assumptions:

1. Max. flood el. 734.7 } April 1965
   T.W. el. 719.0 }
2. Water inside Dam as high as T.W.
3. Uplift by Flow Net Method.

BEARING PRESSURES @ PTS. (A') & (B)



$\overline{X}_{A'} = \frac{30757}{1215} + 4.13 = 29.44$ $\quad e = 30.4 - 29.44 = 0.96$

$f_{(A')} = \frac{1215}{972.8}\left(1 + \frac{6 \times 0.96}{60.8}\right) = 1.36'$

$f_{(B)} = \frac{1215}{972.8}(1 - .095) = 1.13$

Concrete
Resurfac

F_1
F_2

W_1
W_2
W_3
W_4 $24 \times 16 \times \frac{1}{2} \times$
W_5 $22 \times 17.3 \times \frac{1}{2}$
W_6 $8.3 \times 17.3 \times$
W_7 $10.7 \times 17.3 \times$

U_1
U_2
U_3

H_1
H_2
H_3

HS15
WS15

Additional s
below

3

A'

(A') =
(B) =

R.N.M. 1-13-75 J1 3/25/75 124
690.6

		→(+) (Kips)	↓	(Kips)	(feet)	↷		
	Concrete D.L.		1177				34304	From Norma Condition
	Resurfacing		79				778	
F_1			264				7656	Sand Fill
F_2			294				8526	
W_1			326				14507	Water, up-stream
W_2			52				2886	
W_3			365				14856	
W_4	$24 \times 16 \times \frac{1}{2} \times .0625 \times 16$		192		5.3		1018	Water, dnstream
W_5	$22 \times 17.3 \times \frac{1}{2} \times 14 \times .0625$		167		35.		5828	Water inside
W_6	$8.3 \times 17.3 \times 14 \times .0625$		126		23.		2889	
W_7	$10.7 \times 17.3 \times \frac{1}{2} \times 14 \times .0625$		81		15.		1215	
U_1				1863		51791		Uplift
U_2				125		4625		
U_3				44		2468		
H_1		+528				5720		Lateral hydrostatic
H_2		+374				6096		
H_3		−403					3820	
HS15		+37				185		Sediment
WS15			29				1556	
							1803	
	Additional submerged Concrete below el. 690.6		95					
		536	3247	2032 ~~1120~~ 1215		70885	99839 ~~29070~~ 30757	

~~30.1~~' 29.44 ft +[redacted]0.96

A'

Ⓐ' = ~~1.19~~ 1.36 KSF
Ⓑ = ~~1.12~~ 1.131 KSF

LOCK AND DAM No. 1
STABILITY OF DAM

2

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF BUTTRESS DAM COMPUTED R.H.M. CHECKED JJ	PROJECT L & D #1 FILE NO. 800 A DATE 4/'75 PAGE 125 OF ___ PAGES

FLOOD DISCHARGE

1965 FLOOD – EXISTING CONDITION

"SLIDING SAFETY FACTOR" AT PLANE AC

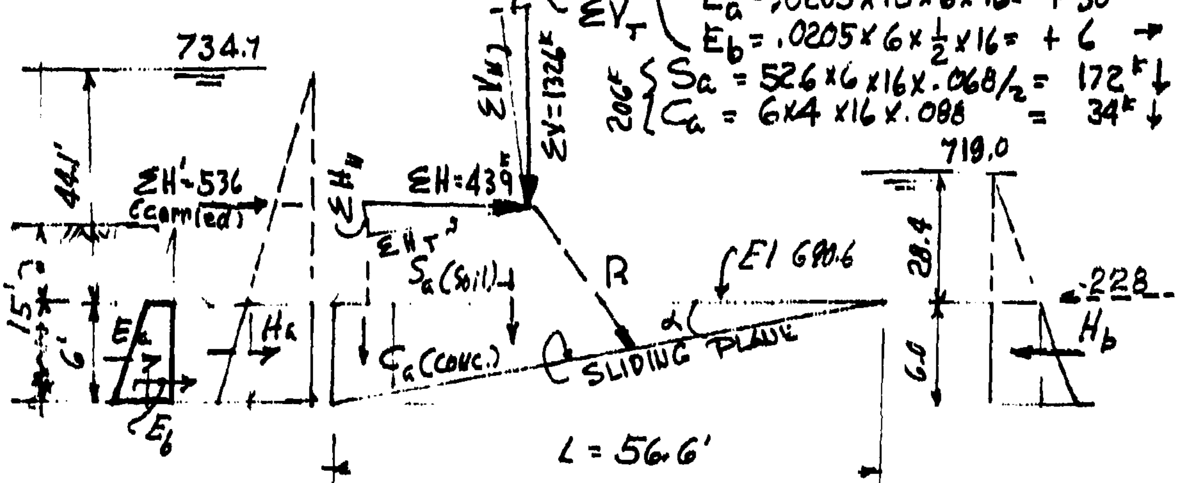
UPLIFT BY FLOW NET METHOD

ADDITIONAL FORCES BELOW EL. 690.6 :

$\Sigma V' = 1120^k$ (Carried)

$131^k = \begin{cases} H_a = 44.1 \times .0625 \times 6 \times 16 = +265^k \rightarrow \\ H_b = 28.4 \times .0625 \times 6 \times 16 = -170^k \leftarrow \\ E_a = .0205 \times 15 \times 6 \times 16 = +30^k \rightarrow \\ E_b = .0205 \times 6 \times \frac{1}{2} \times 16 = +6 \rightarrow \end{cases}$

$206^k \begin{cases} S_a = 526 \times 6 \times 16 \times .068/2 = 172^k \downarrow \\ C_a = 6 \times 4 \times 16 \times .088 = 34^k \downarrow \end{cases}$



$\Sigma H = 536 + 131 - 228 = \underline{439}^k \qquad \Sigma V = 1120 + 206 = \underline{1326}^k$

$\alpha = 6.05°$

$\Sigma H_N = 439 \sin\alpha = 46^k \qquad \Sigma H_T = 439 \cos\alpha = 437^k$

$\Sigma V_N = 1326 \cos\alpha = 1319^k \qquad \Sigma V_T = 1326 \sin\alpha = -140^k$

$\Sigma H_N + \Sigma V_N = 1365^k \qquad \Sigma H_T - \Sigma V_T = 297^k$

$$SSF = \frac{(\Sigma H_N + \Sigma V_N)}{(\Sigma H_T - \Sigma V_T)}(.649) = \frac{1365 \times .649}{297} = \underline{2.98}$$

CHECK: $R = \sqrt{439^2 + 1326^2} = 1398$

$\theta = \tan^{-1}\frac{43}{1326} = 18.32°$

$\underline{-6.05}$

$\angle w = 12.27°$

$R_T = R \sin w = \frac{297}{1366} = .217$

$R_N = R \cos w$

$SSF = \frac{.55}{29/136} = \underline{2.98}$

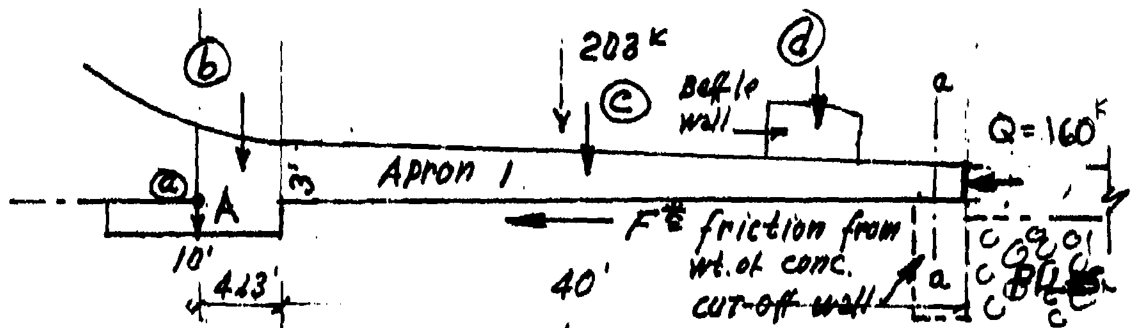
(NEXT SHEET IS P. 125a)

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY ANALYSIS OF BUTTRESS DAM	PROJECT L & D #1
	COMPUTED R.H.M. CHECKED JI	FILE No. 800 A
		DATE 4/'75 PAGE 125a OF ___ PAGES

A. FRICTIONAL RESISTANCE OF SUBMERGED CONCRETE DOWNSTREAM, 44.13 ft. from pt. "A".

B. CRITICAL SHEAR SECTION OF APRON (1) CHECKED FOR ALLOWABLE FORCE REACTION ASSUMING THAT THE CUT-OFF-WALL, APRON (2) & PILES ACT AS A SOLID SUPPORT.



A. Submerged concrete wt downstream of point "A":

(a) $2 \times 10 \times 16 \times .088 = 28$

(b) $3 \times 4.13 \times 16 \times .088 = 17$

(c) $40 \times 3 \times 16 \times .088 = 141$

(d) $\left.\begin{array}{lcr} 3 \times 4 \times 16 & = & 192 \\ -2 \times 2 \times 3 \times 12 & = & -24 \\ 3.5 \times 4 \times 2 & = & 28 \end{array}\right\} \times .088 = 17$

$\underline{203^K} \downarrow$

$F = 203 \times .499 = \underline{101}^K \leftarrow$

$* \; F = \dfrac{203 \times .499}{1.5} = \underline{68}^K$ (with 1.5 safety factor)

B. Shearing capacity of slab at section a-a:

$t = 2'$

$L = 16'$

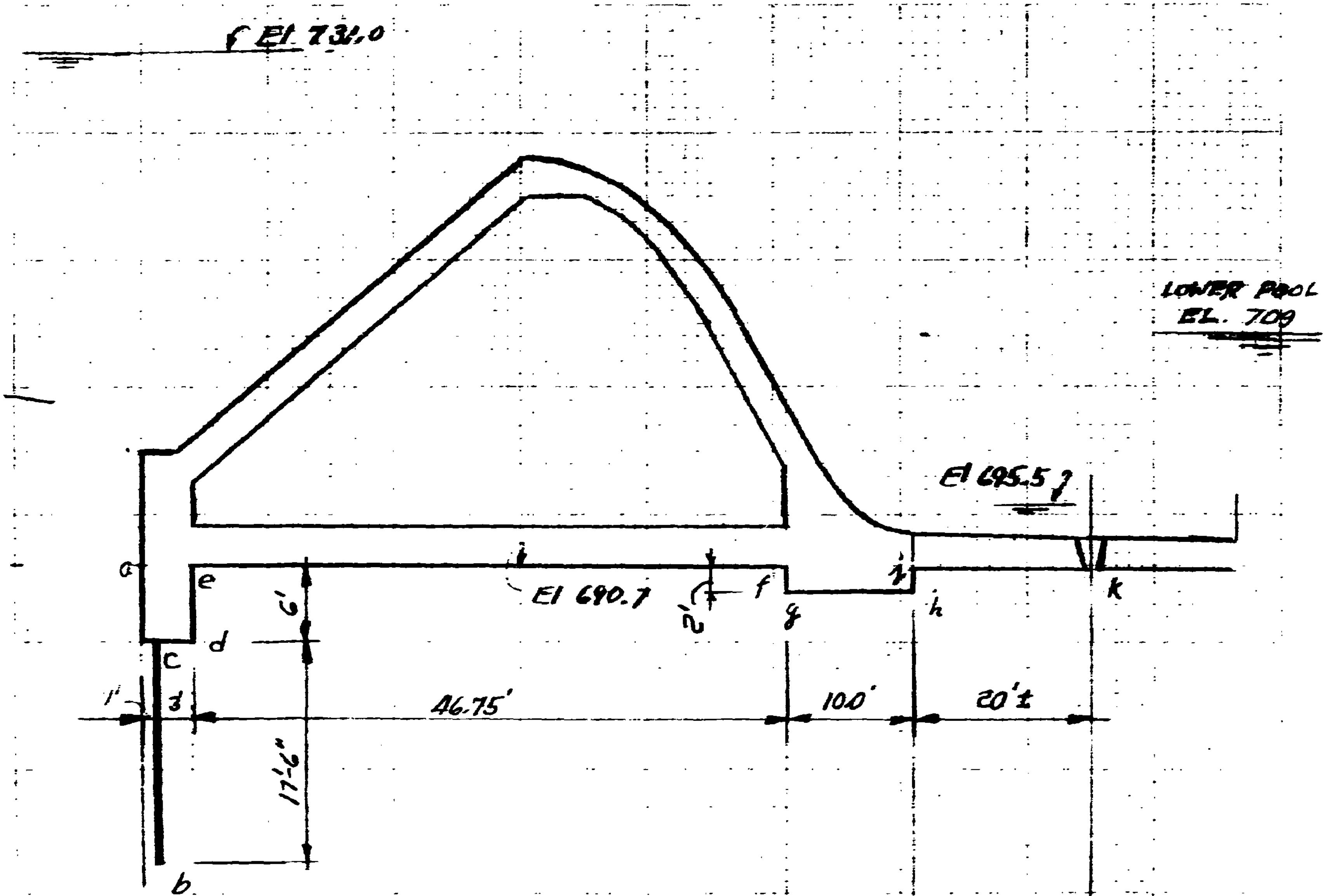
$t \times L = A = 2 \times 16 \times 144 = 4600 \text{ in}^2$

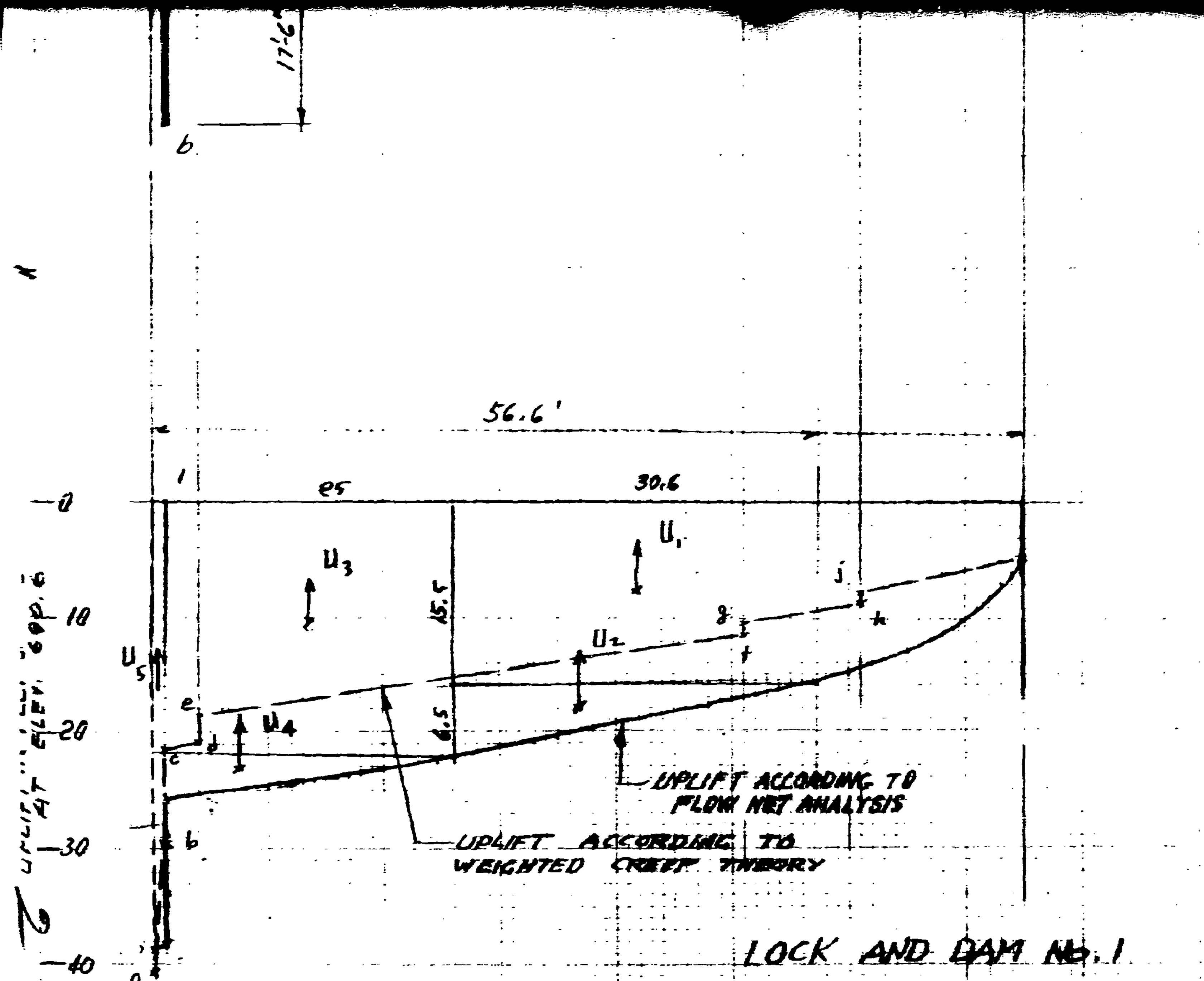
$\tau_c = \dfrac{V}{A} = 60$ psi (Very conservative, $f_c' = 3.0$ ksi)

$V = \underline{60 \times 4600} = \underline{276}^K$

276^K Shall be governed by pile resistance.
Assume 4' spacing e.w., 40 piles per 16' monolith
40 @ 4^K per pile = 160 kips. ∴ Use $\underline{Q = 160^K}$

(PREVIOUS SHEET IS P. 125)


El 731.0
LOWER POOL
EL. 709
El 695.5
El 690.7
a
b
c
d
e
f
g
h
i
j
k
1'
3'
6'
17'-6"
46.75'
10.0'
20'±



LOCK AND DAM No. 1

UPLIFT UNDERNEATH THE DAM

DEC. 9, 1974

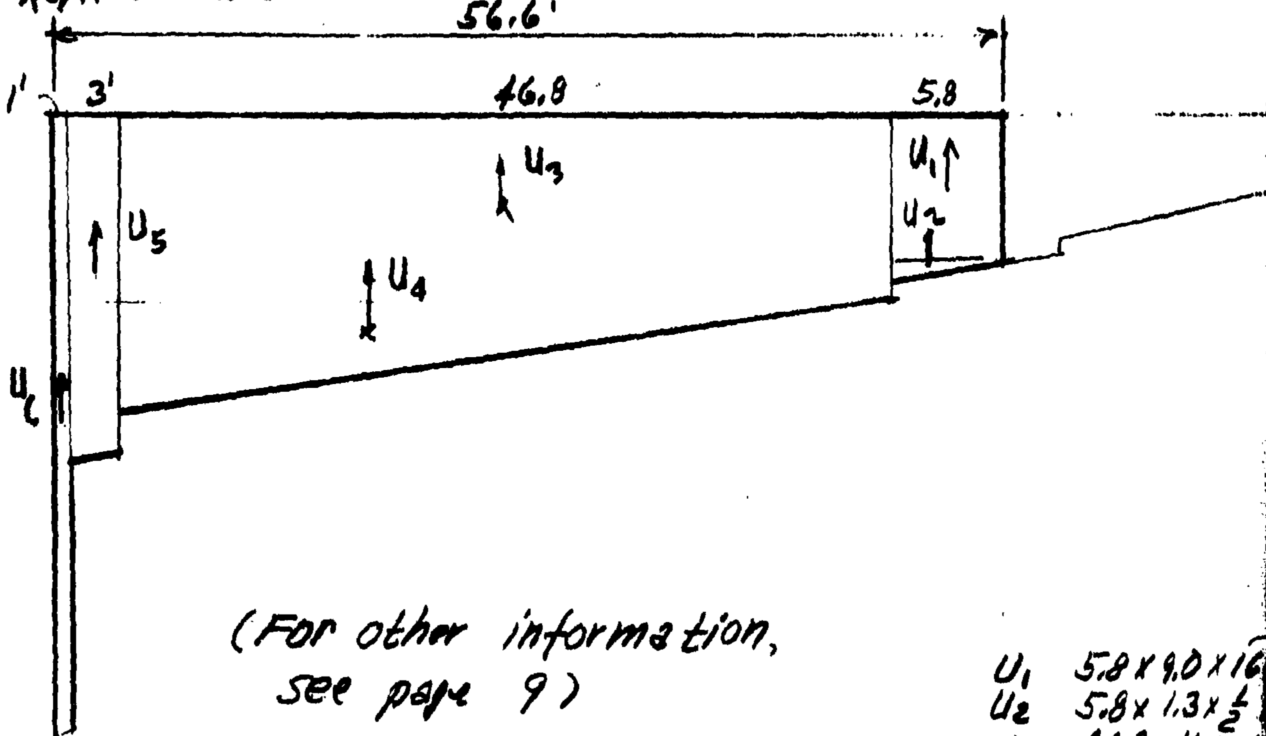
PROJECT 600 A

FLOOD DISCHARGE CONDITION R. N.

1951 FLOOD

Purpose: Determination of uplift using weighted creep theory for comparision with flow net method."
Ref.: DESIGN OF SMALL DAMS

L=(6+1



(For other information, see page 9)

U_1 5.8 x 9.0 x 16

U_2 5.8 x 1.3 x ½

U_3 46.8 x 11.2 x

U_4 46.8 x 7.1 x ½

U_5 3.0 x 21.3 x

U_6 4.0 x 1.0 x

$L = (6 + 17.5 + 2)2 + \frac{80.75}{3} = 77.9'$ $\quad H = 731 - 695.5 = 35.5'$

$r = \frac{L}{H} = 2.1943$ $\quad \boxed{U = \frac{L - x}{r} + 4.8}$

Point	Hor. Dist D(Ft)	$\frac{D}{3}$	Vert. Dist. (Ft)	Creep, x	UPLIFT (Ft. of H_2O)
a					40.4
b	1.0	0.3	23.5	23.8	29.5
c	–	–	17.5	41.3	21.5
d	3.0	1.0		42.3	21.0
e	–	–	6.0	48.3	18.3
f	46.75	15.6		63.9	11.2
g	–	–	2.0	65.9	10.3
h	10.0	3.3		69.2	8.8
j	–	–	2.0	71.2	7.9
K	20.0	6.7		48	4.8

1 $5.8 \times 9.0 \times 16 \times .0625$ — 52
2 $5.8 \times 1.3 \times \frac{1}{2} \times 1.0$ — 4
3 $46.8 \times 11.2 \times 1.0$ — 524
4 $46.8 \times 7.1 \times \frac{1}{2} \times 1.0$ — 166
5 $3.0 \times 21.3 \times 1.0$ — 64
6 $40 \times 1.0 \times 1.0$ — 40

$\Sigma U =$ 850 Creep theory
1208 Flow net Method

∴ USE FLOW NET

LOCK AND DAM No. 1
STABILITY OF DAM

V

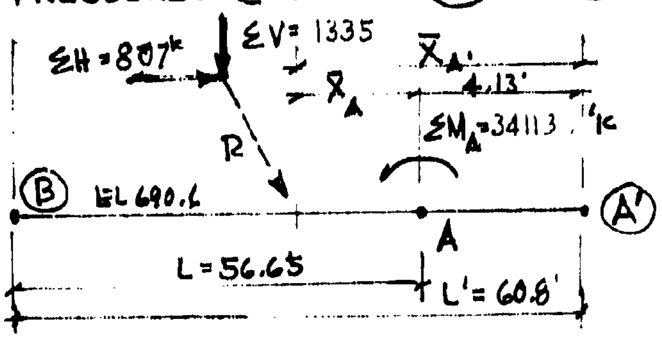
FLOOD DISCHARGE

1951 FLOOD – EXISTING CONDITION

Assumptions:

1. Max. flood el. 731'.
   T.W. el. 695.5 (Lower pool el. 709)
2. Water inside Dam same level as relief hole outlets (697.4 ±)
3. Uplift by flow net method.

BEARING PRESSURES @ POINTS "A'" AN "B"



$\bar{X}_{A'} = \frac{34113}{1335} + 4.13 = 29.68$ ft $\qquad e = 30.4 - \bar{X} = 0.72'$

$f_{A'} = \frac{1335}{972.8}\left(1 + \frac{6 \times 0.72}{60.8}\right) = 1.47$ KSF

$f_B = 1.374(1 - .071) = 1.27$ KSF

Concr
Resur

F_1
F_2

W_1
W_2
W_3

U_1
U_2
U_3
U_4
U_5

H_1
H_2
H_3

HS15
WS15

Subm

A'

R.N.M. 12-10-74 JI 3/26/75 128 194

690.6

Concrete D.L.		1177			34304	From nor condition
Resurfacing		79			778	
F_1		244			7076	Existing sand fill
F_2		294			8526	
W_1		326			14507	Water up- stream.
W_2		52			2886	
W_3		247			10053	
U_1			474	7252		Uplift.
U_2			99	2020		
U_3			550	23705		
U_4			45	2129		
U_5			40	2244		
H_1	+528			5720		Lateral hydrostati
H_2	+254			4140		
H_3	−12				19	
HS15	+37			185		Sediment
WS15		29			1556	
Submerged conc. below elev. 690.6		95			1803	
	807	2543	1208 1335 ↓	47395	81508 34113	

A' 29.68 ft 0.72

A' = 1.47 ksf

B 1.07 ksf

LOCK AND DAM No. 1
STABILITY OF DAM

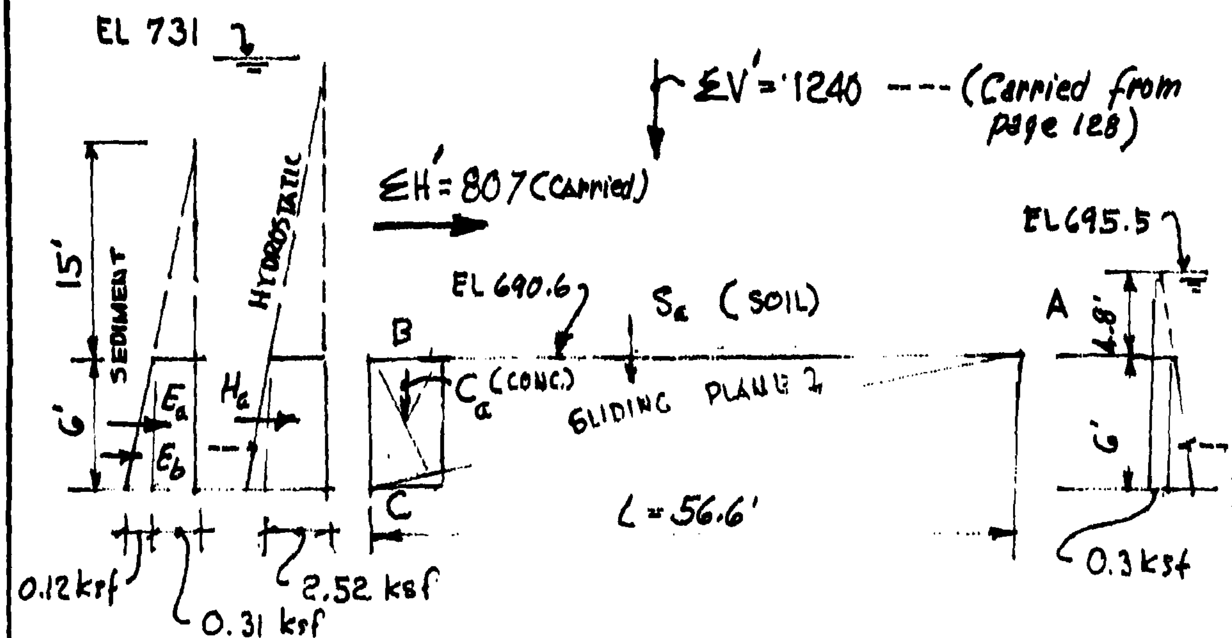
2

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF BUTTRESS DAM	PROJECT L & D # 1
	COMPUTED R.N.M. CHECKED [illegible]	FILE No. 800A
		DATE 4/'75 PAGE 129 OF PAGES

1951 FLOOD - EXISTING CONDITION

SLIDING SAFETY FACTOR AT PLANE AC

ADDITIONAL FORCES BELOW EL. 690.6 :



$$\Sigma H' = 807$$

$$H_a = (2.52 - 0.3)(16 \times 6) = +211$$

$$E_a = 0.31 \times 6 \times 16 = +30$$

$$E_b = 0.12 \times 6 \times 16 \times \tfrac{1}{2} = +6$$

$$\Sigma H = 1054^k \rightarrow$$

$$\Sigma V' = 1240^k$$

S_a = - - - - - - - - - 172

C_a - - - - - - - - - - 34

$$\Sigma V = 1446^K$$

SEE CONTINUATION ON PAGE 129 a

(NEXT SHEET IS P. 129 a)

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF BUTTRESS DAM COMPUTED R.N.M. CHECKED JI	PROJECT LOCK & DAM NO 1 FILE NO. 800 A DATE 4/75 PAGE 129a OF PAGES

BUTTRESS DAM
1951 FLOOD — EXISTING CONDITION

DETERMINATION OF FACTOR OF SAFETY AGAINST SLIDING, (S.S.F.)

$$\boxed{(\Sigma H_N + \Sigma V_N)\frac{.649}{SSF} = \Sigma H_T - \Sigma V_T}$$

$\Sigma H' = 1054 \quad \Sigma H = 1054 - 228 = 826^k \quad \Sigma V = 1446^k$

$$\left.\begin{aligned} \Sigma H_N &= 826 \sin 6.05° = 87 \\ \Sigma V_N &= 1446 \cos 6.05° = 1438 \end{aligned}\right\} 1525$$

$$\left.\begin{aligned} \Sigma H_T &= 826 \cos 6.05° = 821 \\ -\Sigma V_T &= 1446 \sin 6.05 = -152 \end{aligned}\right\} 669$$

$$S.S.F. = \frac{1524 \times .649}{66} = \underline{1.48}, < 1.5$$

CHECK:

$$R = \sqrt{826^2 + 1446^2} = 1665$$

$$\Theta = \tan^{-1}\frac{826}{1446} = 29.74°$$

$$\alpha = -\underline{6.05}°$$

$$\omega = 23.69°$$

$$\frac{R_T}{R_N} = \frac{R \sin \omega}{R \cos \omega} = \frac{669^k}{1525^k} = .439$$

$$SSF = 1.48$$

PREVIOUS SHEET IS P. 129

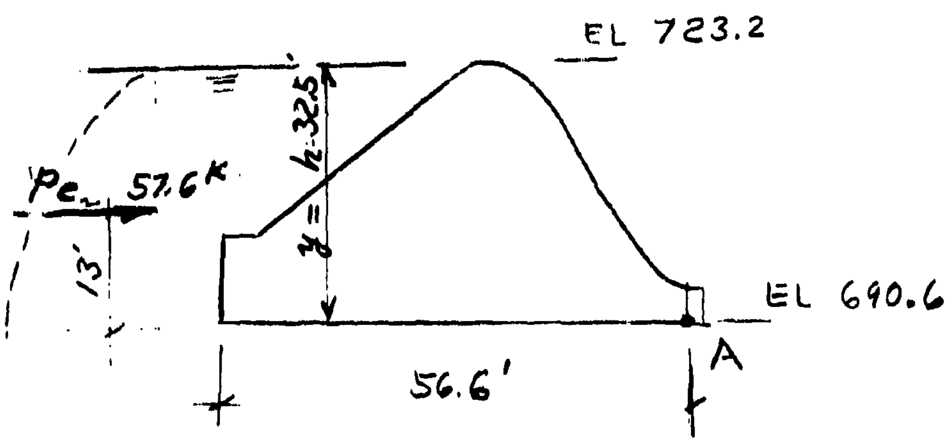
EARTHQUAKE CONDITION

(NORMAL CONDITION WITH EARTHQUAKE)

ASSUMPTIONS:

EARTHQUAKE INERTIA AND HYDRODYNAMIC FORCES ADDED TO AND ICE PRESSURE REMOVED FROM NORMAL OPERATING CONDITION.

ACCELERATION IN UPSTREAM DIRECTION.



Normal c

Less Ice p

Pe_2 Hydrod

Inertia

1	5.9 x
2	75 x
3	67 x
4	9 x
5	221 x
6	58 x
7	28 x
8	54 x
9	337 x
10	76 x
11	3 x
12	0.3
13	0.2
14	56
15	4
16	6 x
17	3 x

R. N. M. 8/74 J1 3/26/75 130 197

690.6

Normal condition - - - +725. 1631 36082

Less Ice pressure -160. 5200

41282

P_{e_2} Hydrodynamic 3.6x16 + 57.6 13.0 749

Inertia forces:

1	59 x 0.1	+5.8	11.5	68
2	75 x 0.1	+ 7.5	18.3	137
3	69 x 0.1	+ 6.9	26.0	179
4	9 x 0.1	+ 0.9	31.0	28
5	221 x 0.1	+ 22.1	25.0	553
6	58 x 0.1	+ 5.8	14.2	82
7	28 x 0.1	+ 2.8	6.0	17
8	54 x 0.1	+ 5.4	2.0	108
9	337 x 0.1	+ 33.7	1.5	51
10	96 x 0.1	+ 9.6	5.0	48
11	3 x 0.1	+ 0.3	10.0	3
12	0.3 x 0.1	—	—	
13	0.25 x 0.1	—	—	
14	56 x 0.1	+ 5.6	4.0	22
15	4 x 0.1	0.4	4.5	2
16	6 x 0.1	0.6	5.0	3
17	3 x 0.1	0.3	10.0	3
		157.1		2253

LOCK & DAM #1
STABILITY OF DAM

EARTHQUAKE CONDITION (CONT'D)

Corps of Engineers' Formula

(Pg 5, "SMALL DAM DESIGN")

$$\boxed{Pe_x = \frac{2}{3} C_e \alpha y \sqrt{hy}}$$

$$C_e = \frac{51}{\sqrt{1-0.72\left(\frac{h}{1000\, t_e}\right)^2}} = 51$$

t_e = Earthquake vibration pd. = 1 sec.

h = total height of dam = 32.5'

y = depth of water = y

$$Pe_x = \frac{2}{3} \times 51. \times 0.1 \times 32.5 \sqrt{32.5^2} = \underline{\underline{3.6}}^{k}/ft.$$

18	3
19	7
20	5
21	2
22	52
23	3
-24	0
25	3
-5a	7
-5b	4
-5c	2
-10a	4
26	–
27	–
28	–
29	4
30	9
31	7
32	1
33	4
34	–
35	–
36	–
37	4
38	1
39	4

15

R.N.M. 8/74 J1 3/26/75 131

690.6

18	3 x 0.1	+ 0.3	10.0	3	
19	7 x 0.1	+ 0.7	5.7	4	
20	5 x 0.1	+ 0.5	7.5	4	
21	2 x 0.1	+ 0.2	7.5	2	
22	52 x 0.1	+ 5.2	8.5	44	
23	3 x 0.1	+ 0.3	18.0	5	
-24	0.3 x 0.1	—	—		
25	3 x 0.1	+ 0.3	18.0	5	
-5a	77 x 0.1	- 7.7	25.0		193
-5b	42 x 0.1	- 4.2	23.5		99
-5c	29 x 0.1	- 2.9	22.0		64
-10a	4 x 0.1	- 0.4	9.4		4
26	3 x 0.1	+ 0.3	18.0	5	
27	12 x 0.1	+ 1.2	13.5	16	
28	5 x 0.1	+ 0.5	13.5	7	
29	42 x 0.1	+ 4.2	15.0	63	
30	9 x 0.1	+ 0.9	21.3	19	
31	7 x 0.1	+ 0.7	22.7	16	
/ft. 32	11 x 0.1	+ 1.1	21.0	23	
33	4 x 0.1	-0.4	22.0		9 369
34	14 x 0.1	+ 1.4	9.2	13	
35	19 x 0.1	+ 1.9	16.2	31	
36	19 x 0.1	+ 1.9	24.0	46	
37	4 x 0.1	+ 0.4	28.0	11	
38	11 x 0.1	+ 1.1	25.0	28	
39	4 x 0.1	+ 0.4 41	20.4	8 251	

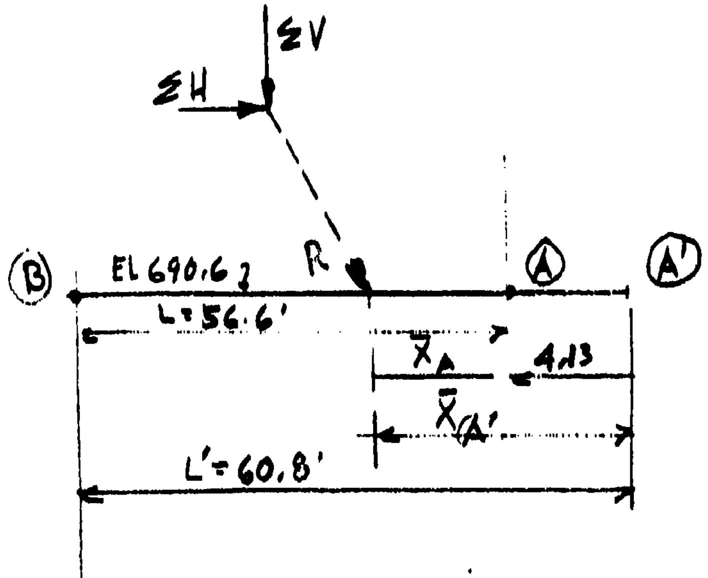
LOCK & DAM #1
STABILITY OF DA

2

1

NORMAL OPERATING CONDITION

WITH EARTH QUAKE (CONT'D)



40
41 } 20

42
43
44
45

F 53

WS_{IK} 28

BEARING PRESSURES:

$\Sigma V = 1726^{k} \quad \Sigma M_A = 40496\ '^{k}$

$$\bar{X}_{A'} = \frac{40496}{1726} + 4.13 = 27.59'$$

$$f_{(A')} = \frac{1726}{972.8}\left(1 + \frac{6 \times 2.81}{60.8}\right) = 2.27$$

$$f_{(B)} = 1.77\,(1 - 0.28) = 1.28$$

Sub

(A')

R N M 8/74 J/ 3/26/75 132 199

690.6

40 } 41 }	20 x 0.1	+2.0	14.0	28
42	38 x 0.1	+ 3.8	14.7	56
43	13 x 0.1	+ 1.3	6.0	8
44	18 x 0.1	+ 1.8	25.6	46
45	10 x 0.1	+ 1.0 / 1.9	31.2	31 / 169
F	535 x 0.1	+ 53.5	6.5	348
WS_{15}	28 x .1	+ 2.8	12.4	35

Submerged concrete below el. 690.6 95 1803

804 1726 2958 43454

40496

+ 4.13 = 27.59' e' = 2.81'

(A')

(A') = 2.27 ksf

(B) = 1.28 ksf

LOCK & DAM #1

STABILITY OF DAM

2

EARTHQUAKE CONDITION

Sliding Safety Factor @ Plane AC

$R = \sqrt{807^2 + 1837^2} = 2006^K$

$\tan^{-1}\theta \quad \tan^{-1}\frac{807}{1837} = 23.72^\circ$

$d = \underline{6.05^\circ}$

17.67°

$R_T = R \sin \omega = 609^K$

$R_N = R \cos \omega = 1911^K$

Sliding factor $= \frac{609}{1911} = .319$

$SSF = \frac{.649}{.319} = 2.03$

Below

H_a
E_a
E_b
S_a
C_a

40 piles @ 4

$\frac{203^K \times .55}{1.5}$

RNM ·/14 JI 3/26/75 153 200
690.6 - 684.6

804 1631

Below el. 690.6 :

H_a
E_a } +231
E_b
S_a } 206
C_a

} From normal condition

40 piles @ 4^k per pile -160^k

$\frac{203^k \times .55}{1.5}$ -68

Friction from Weight of Apron

807^k

1837

LOCK AND DAM No. 1
STABILITY OF DAM

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILITY OF BUTTRESS DAM	PROJECT L&D #1
	COMPUTED DRB CHECKED RM	FILE NO. 800 A
		DATE 4/76 PAGE 134 OF ___ PAGES

FLOOD DISCHARGE

1951 FLOOD - IMPROVED CONDITION

$\Sigma M_A' = 34113$ (Pg. 128)

MAX. FLOOD EL. 731. -
LOWER POOL EL 709. -
TAILWATER ELEVATION @ APRON 695.5'

$M_{A\,\text{Fill}} \quad 17 \times \dfrac{12.8}{476}{}'^{k}$

$\Sigma V' = 1335^k$ (PAGE 128)
$\underline{17^k}$ (ADDITIONAL FILL - PAGE 135)
$\Sigma V = 1352^k$ (ABOVE ELEVATION 690.6)
$\Sigma H = 807^k$ (" " ")(PAGE 128)
$\Sigma M_A = 34113 + 476 = 34589'^k$

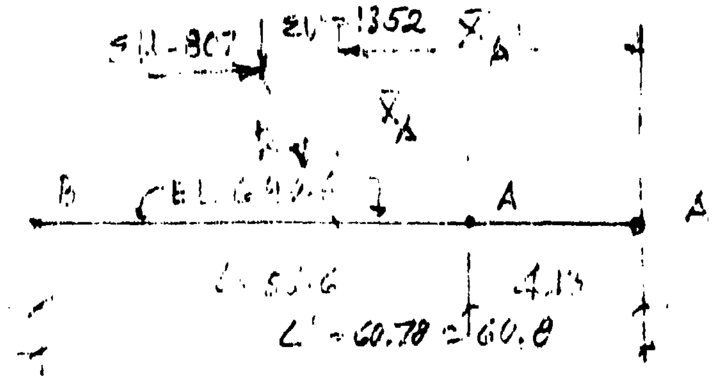
FOR BEARING PRESSURES, $L' = 60.8'$ (from A' to B)
$\bar{X}_{A'} = \bar{X}_A + 4.13'$, AREA = 972.8

$$\bar{X}_{A'} = \frac{34589'^k}{1352^k} + 4.13 = 29.71'$$

$$e_{A'} = 30.4 - 29.71 = 0.69 \text{ ft.}$$

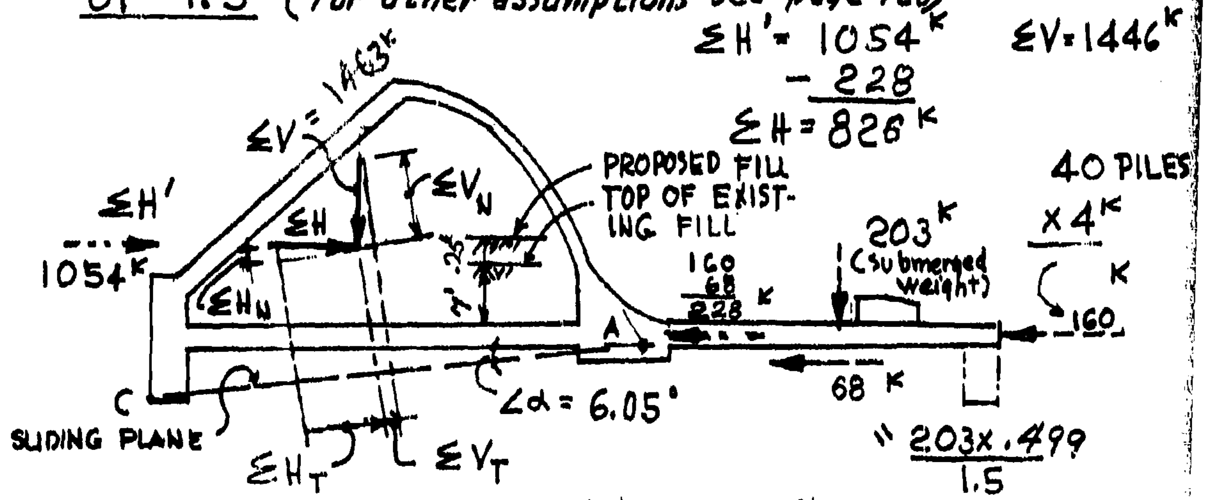
$$f_{A'} = \frac{1352}{972.8}\left(1 + \frac{(6)(0.69)}{60.8}\right) = 1.48 \text{ KSF}$$

$$f_B = \frac{1352}{972.8}\left(1 - \frac{(6)(0.69)}{60.8}\right) = 1.30 \text{ KSF}$$



BUTTRESS DAM
1951 FLOOD – IMPROVED CONDITION

DETERMINATION OF REQUIRED HEIGHT OF ADDITIONAL SAND FILL FOR A FACTOR OF SAFETY AGAINST SLIDING OF 1.5 (For other assumptions see page 128)



$$(\Sigma H_N + \Sigma V_N)\left(\frac{0.649}{1.5}\right) = \Sigma H_T - \Sigma V_T$$

$$\left(826 \sin 6.05° + \Sigma V \cos 6.05°\right)\left(\frac{0.649}{1.5}\right) = 826 \cos 6.05° - \Sigma V \sin 6.05°$$

$$(87 + 0.9944\,\Sigma V)(0.4326) = 821 - 0.1053\,\Sigma V$$

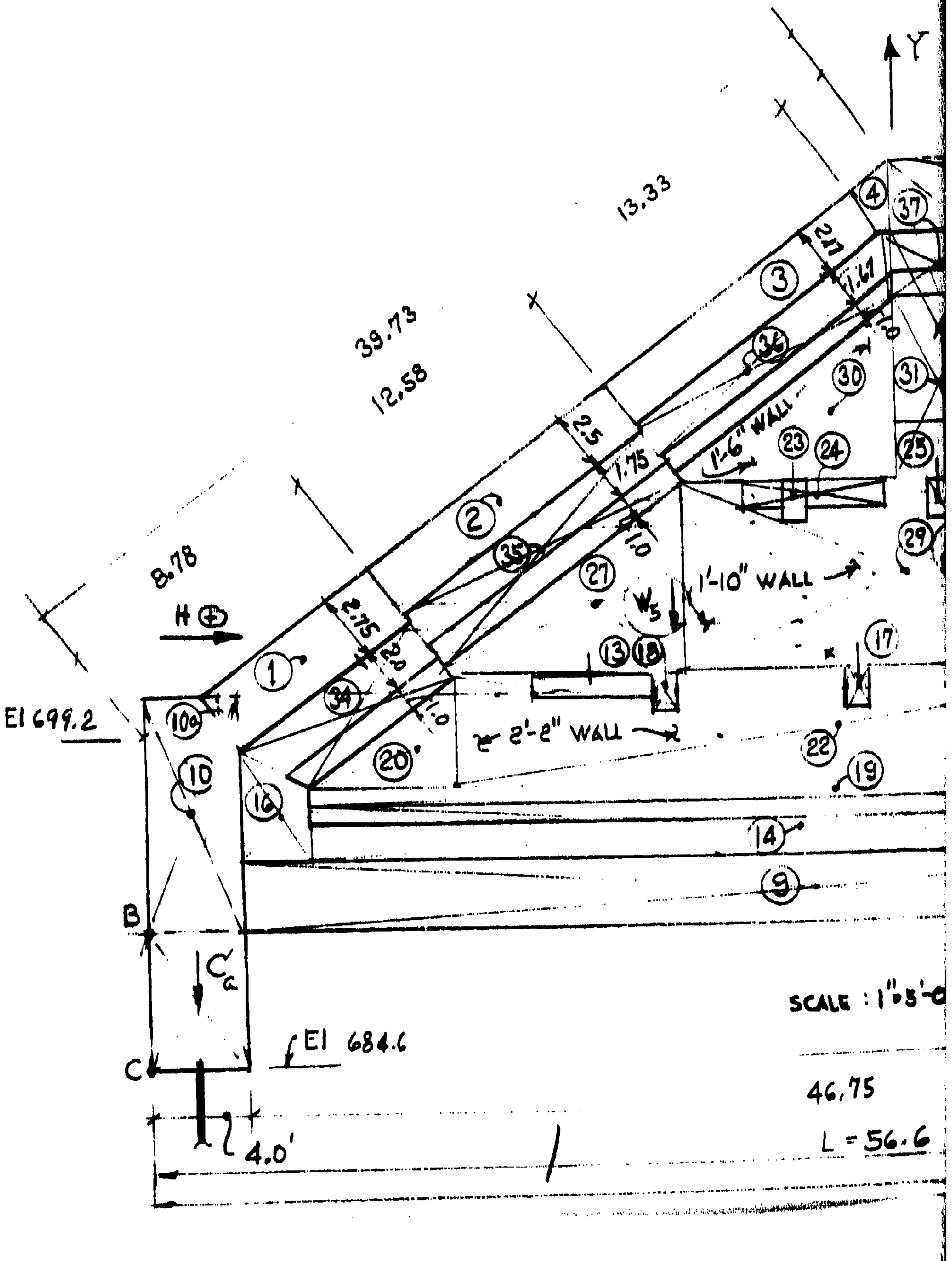
$$37.6 + 0.4302\,\Sigma V = 821 - 0.1053\,\Sigma V$$

$$0.5355\,\Sigma V = 783.4$$

$$\therefore \underline{\Sigma V = 1463^k}$$

ΣV FOR EXISTING CONDITION = 1446^k

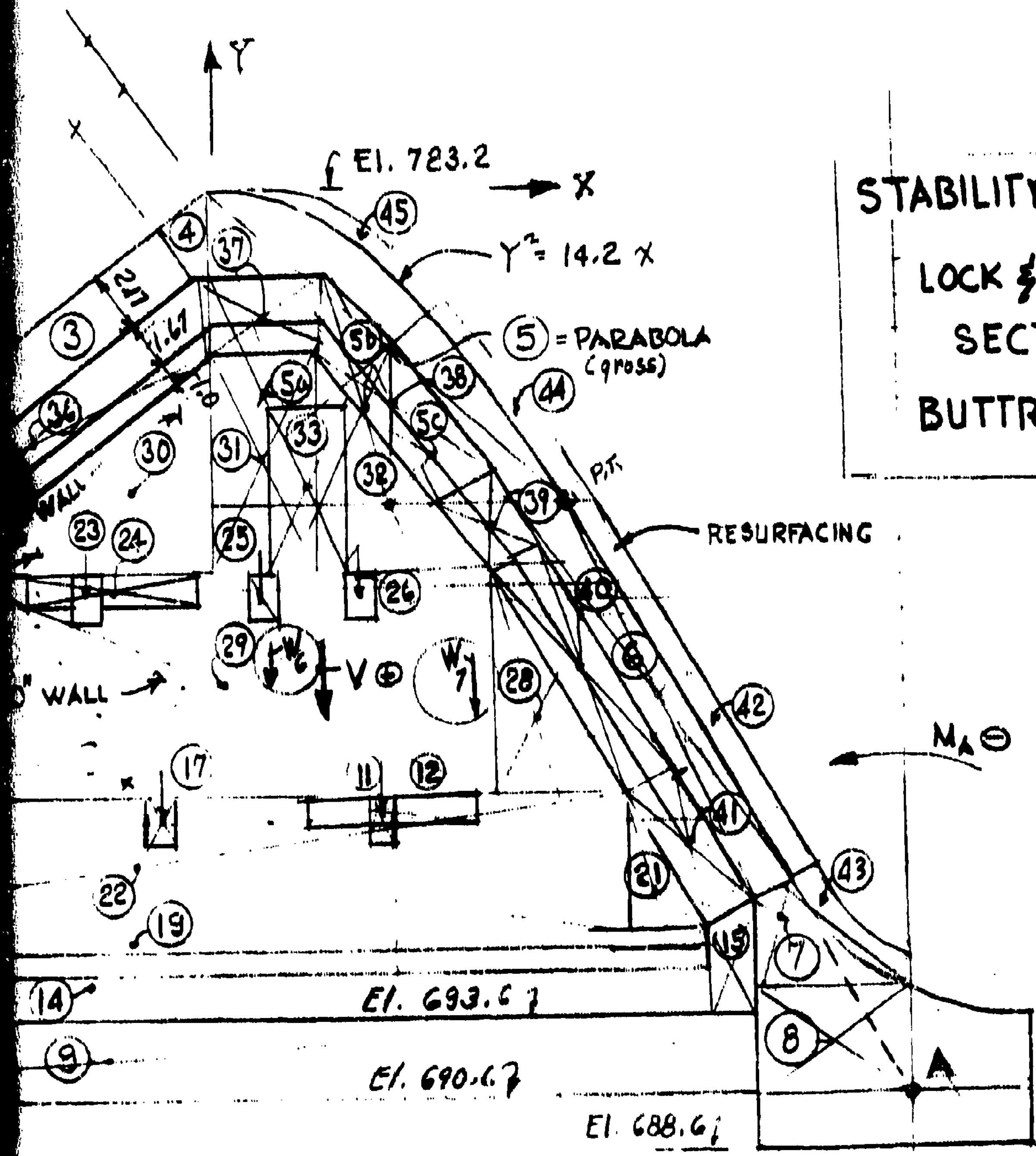
REQUIRED WEIGHT OF ADDITIONAL FILL = 17^k
REQUIRED HEIGHT OF ADDITIONAL FILL = $0.25'^{+}$



Y
13.33
39.73
12.58
8.78
H ⊕
2.17
1.61
1.0
2.5
1.75
1.0
2.75
2.0
1.0
1'-6" WALL
1'-10" WALL
2'-2" WALL
W_5
El 699.2
El 684.6
B
C
C_a
4.0'
SCALE : 1" = 5'-0
46.75
L = 56.6

STABILITY ANALYSIS

LOCK & DAM No. 1
SECTION thru
BUTTRESS DAM



SCALE : 1" = 5'-0"

46.75

L. = 56.6 Ft

L' = 60.8'

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT COFFERDAMS	PROJECT LOCK & DAM No 1
		FILE No 800 A
	COMPUTED R.N.M. CHECKED JJ	DATE 4/19/75 PAGE ___ OF ___ PAGES

UPSTREAM & DOWNSTREAM COFFERDAMS

UPSTREAM $H = 733 - 708 = 25$ FT

DOWSTREAM $H = 705 - 674 = 31$ FT

STABILITY OF DOWNSTREAM COFFERDAM

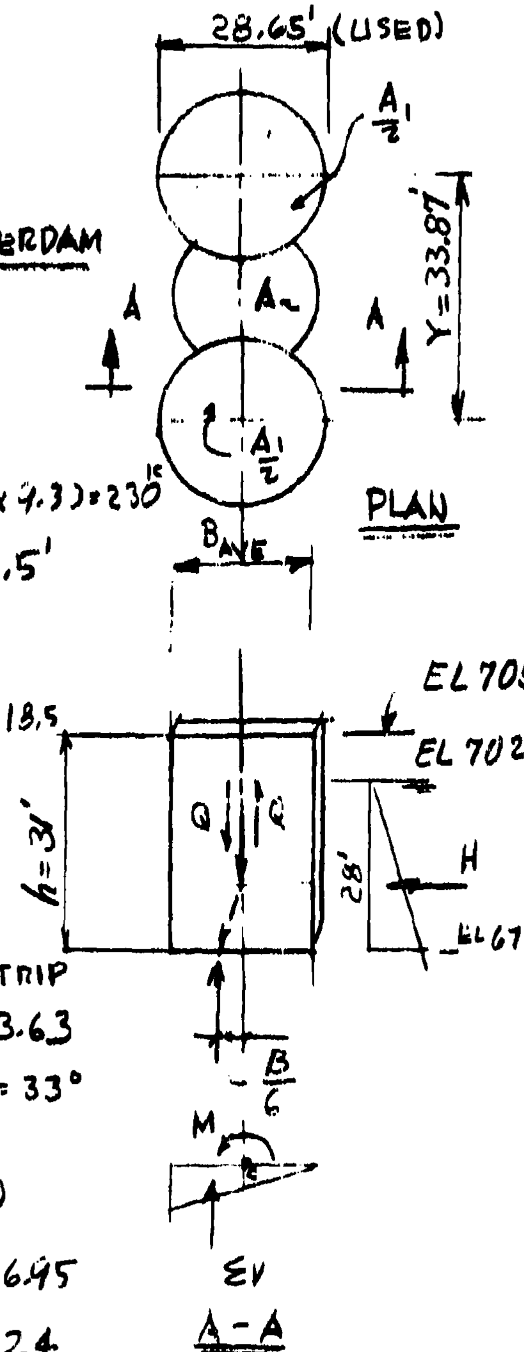
1. OVERTURNING $w = 130$ PCF

$\Sigma M_c = 0, \quad wh\,B\left(\frac{B}{6}\right) = M$

$B_{REQ'D} = \sqrt{\frac{6M}{wh}} = \sqrt{\frac{6 \times 230}{.13 \times 31}} = 18.5'$ $\quad M = \frac{28^2}{2} \times .0625 \times 9.3) = 230^{k}$

B_{AVE} (USED) $= \frac{A_1 + A_2}{Y}$

$= \frac{646.9 + 210.4}{33.87} = 25.31' > 18.5$ o.k.



2. VERTICAL SHEAR @ ℄

Q = VERTICAL SHEAR PER FT STRIP

$= \frac{3}{2}\frac{M}{B} = \frac{1.5 \times 230}{25.31} = 13.63$

$\phi = 33°$

R = SHEARING RESISTANCE

$= \frac{Kwh^2}{2}(\tan\phi + .30 \times .9)$

$= \frac{.295 \times .13 \times 31^2}{2}(.92) = 16.95$

$F.S. = \frac{R}{Q} = \frac{16.95}{13.63} = \underline{1.24}$

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT COFFERDAMS	PROJECT L & D #1
		FILE No. 800A
	COMPUTED R.N.M. CHECKED JI	DATE 4/14/75 PAGE ___ OF ___ PAGES

DOWNSTREAM COFFERDAM (CONT'D)

3. INTERLOCK TENSION

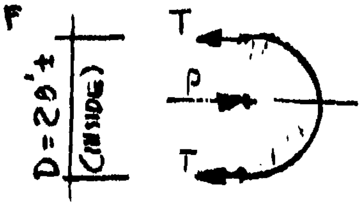
UNIT PRESSURE @ BOTTOM

$Kwh = .295 \times 0.13 \times 31 = 1.19\ KSF$

$P = Kwh(D) = 1.19 \times 28 - 33.32^{k}/ft$

$T = \frac{P}{2} = 16.66^{k}/LIN.FT.$

$= 1.4^{k}/LIN.INCH < 8^{k}$



RECOMMENDED DESIGN STRESS IN INTERLOCKS OF SECTION MP-101 = 8^{k}/LIN. INCH.

UPSTREAM COFFERDAM WILL BE THE SAME AS DOWNSTREAM COFFERDAM

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT CONSTRUCTION ENCLOSURE COMPUTED M.J. CHECKED RNM	PROJECT LED #1 FILE NO. 800A DATE 12.74 PAGE 1 OF 5 PAGES

CONSTRUCTION ENCLOSURE STRUCTURE

DL & LL 30PSF

ASSUME SPACING OF SUPPORTS 10'-0 ON CTRS

LOAD ON TRUSS 10×30 = 300#/FT

.30×64 + .03×64 = 19.20 + 1.92 = 21.12 k

USE 44 LJ 12, ALLOWABLE LOAD 23.10 k

SPACING OF BMS 7'-4

LOAD ON BMS 7.33×.03 = .22 k/'

TOTAL LOAD/BM .22×10.0 = 2.2 k/BM

USE M6×4.4, ALLOWABLE LOAD 3.8 k/BM

USE 2×6 TIMBER @ 2'-0 CTRS FOR ROOF COVER

BEAM @ I-WALL

LOAD ~.35 k/FT

TOTAL LOAD ON BM .35×29 = 10.2 k

USE W 16×26

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT CONSTRUCTION SHELTER	PROJECT L & D #1
	COMPUTED M.J. CHECKED RNM	FILE No. 800A
		DATE 12.5.74 PAGE 2 OF ___ PAGES

ESTIMATE OF MATERIALS FOR CONSTRUCTION SHELTER

ROOF TRUSSES (LJ JOISTS)

64.0 × 30 = 1.92 k/TRUSS

2 × 54 × 1.92 = 208 k

SECONDARY TRUSSES & BRIDGING = 116 k SEE NEXT SHT.

TRUSS STEEL TOTAL = 324.0 k

BEAMS 19 LINES × 532' LG C ABT 7' CTRS

M6×4.4 19 × 532 × .0044 = 45.0 k

W8×17 4 × 532 × .0170 = 36.2

W16×26 29 × .026 × 54 = 40.8

TOTAL = 122.0 k

COLUMNS

12 × 4 × .017 × 54 = 44.0 k

BASE PLS 4 × 54 × .025 ~= 6.0

50.0 k

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT CONSTRUCTION SHELTER	PROJECT LED #1
		FILE NO. 800A
	COMPUTED M.J. CHECKED RNM	DATE 1274 PAGE 3 OF ___ PAGES

ESTIMATE OF MATERIALS FOR CONSTRUCTION SHELTER

ROOF TRUSSES (CONT'ED)

BRIDGING FOR TRUSSES

8 LINES OF BRIDGING 532' LG

$8 \times 532 \times 2 \times 1.06 \times .005 = 45.2^k$

TRUSSES @ BOTTOM OF JOISTS, ~ 100' SPACING, 6 REQ'D

$6 \times 2 \times 640 \times \overset{WT/FT}{.09} = 70.0^k$

BRIDGING AND SECONDARY TRUSSES TOTAL 116.0^k

BRACING FOR COL'S

$2 \times 18.8 \times .010 \times 54 = 21.0^k$ CENTER BAY

$4 \times 17 \times 25.5 \times .005 = 9.0$ AT 4 ROWS OF COL'S

BRACING TOTAL = 30.0^k

ESTIMATE OF STEEL FOR CONSTRUCTION SHELTER

ROOF TRUSSES	324 k	SAY	164	TON
BEAMS	172 k		86	"
BRACING Ls	100 k		50	"

TOTAL STEEL REQ'D 300 TON

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT QTO — SHELTER	PROJECT L & D #1
	COMPUTED R.N.M. CHECKED JI	FILE No 800 A
		DATE 4/14/75 PAGE 5 OF PAGES

REHABILITATION OF BOTH LOCKS

LUMBER: 1X6 160 X 535 = 86,000 BOARD FT

2x8 160 x 266 x1.33 = 57,000 " "

TOTAL = 143,000 " "

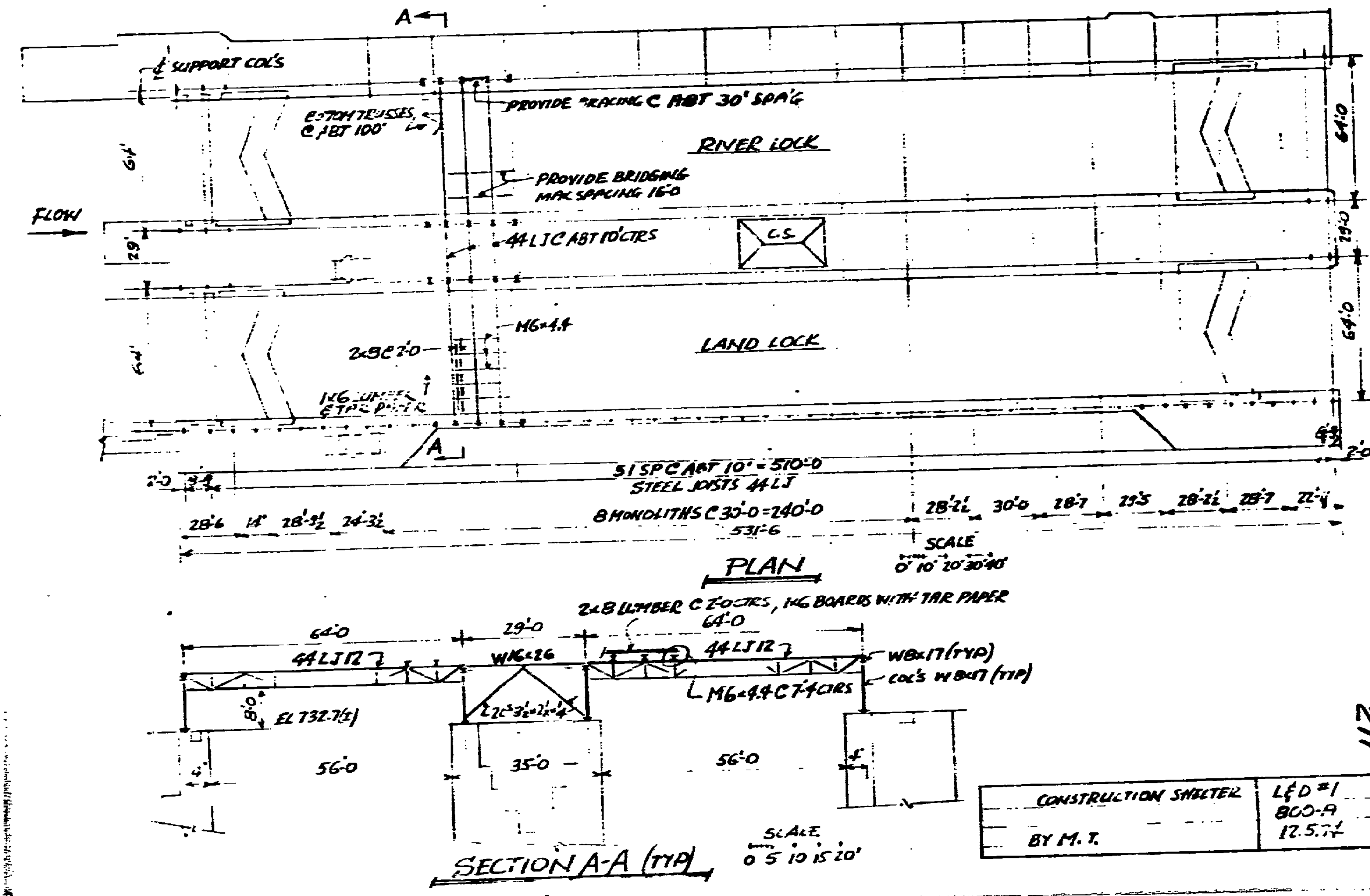
TAR PAPER: (86,000)1.1 = 95,000 FT²

CANVASS:

12' HIGH ALL AROUND
(157 + 532) 2 x 12 — — — = 17,000

LOCK OPENINGS 56(28+57)2 = 10,000

TOTAL 27,000 FT²


SUPPORT COL'S
PROVIDE BRACING C ABT 30' SPA'G
BOTTOM TRUSSES C ABT 100'
RIVER LOCK
PROVIDE BRIDGING MAX SPACING 16-0
FLOW
44 LJ C ABT 10' CTRS
C.S.
M6×4.4
2×8 C 2'-0
LAND LOCK
A
51 SPC ABT 10' = 510-0
STEEL JOISTS 44 LJ
8 MONOLITHS C 30-0 = 240-0
531-6
28-6
14'
24-3½
28-2½
30-0
28-7
29-5
SCALE
0' 10' 20' 30' 40'
PLAN
2×8 LUMBER C 2' CTRS, 1×6 BOARDS WITH TAR PAPER
64-0
29-0
44 LJ 12
W16×26
W8×17 (TYP)
COL'S W8×17 (TYP)
M6×4.4 C 7'-4 CTRS
EL 732-7(±)
56-0
35-0
SECTION A-A (TYP)
SCALE
0 5 10 15 20'
CONSTRUCTION SHELTER
BY M.T.
L&D #1
800-A
12.5.74

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT QTO — SHELTER REHABILITATION OF LAND LOCK COMPUTED R.N.M. CHECKED JI	PROJECT L & DAM #1 FILE NO. 800A DATE 4/10/75 PAGE 7 OF 9 PAGES

STEEL

① ROOF TRUSS (LJ BAR JOISTS)

1.92 K/TRUSS, 1 X 54 X 1.92 = 104 K

② BRIDGING

4 SETS/BAY,
x 53 BAYS
x 22' LONG/SET
x 5 #/FT
} — — — — — — — — 23 K

③ SECONDARY TRUSSES @ BOTTOM OF JOISTS SPACED 100' (6 REQ'D/LOCK)

6 X 64 X .09 — — — — — — — — 35 K

4) M6 X 4.4 BEAMS (SPACED 7'-4")

$\left(\frac{64}{7.33}+1\right) \times 530 \times 4.4$ — — — — — 23 K

5 W8 X 17 COLUMNS

12 X 3 X .017 X 54 — — — — — — — — 33 K

⑥ W16 X 26 29 X .026 X 54 — — — — 41 K

⑦ W8 X 17 — 3 X 10 X 54 X 17 — — — — 28 K
⑧ BASE PL 3 X 54 X .025 — — — — — 4 K
⑨ COL. BRACE, CENTER BAY — 2 X 18.5 X .010 X 54 = 21 K
10 3 ROWS COL. — 3 X 17 X 25.5 X .005 = 7

TOTAL FOR STEEL = $\frac{319}{2}$ (1.14) = 180 TONS

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT QTO – SHELTER REHABILITATION OF LAND LOCK	PROJECT L&D #1
	COMPUTED R.N.M. CHECKED J	FILE NO 800A
		DATE 4/10/75 PAGE 8 OF 9 PAGES

LUMBER

1" x 6" 94 x 535 = 51,000

2" x 8" 94 x 266 x 1.33 = 34,000

TOTAL = 85,000 BOARD FEET

TAR PAPER

51,000 + (10%) 51,000 = 56,000 FT^2

CANVAS

12' HIGH ENCLOSURE

(93 + 532) 2 x 12 = 15,000

LOCK OPENINGS

56 x (28+57) = 4,760

19,760 say

TOTAL FOR CANVAS = 20,000 FT^2

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT QTO - SHELTOR PLAN 2 & PLAN 4 COMPUTED R.N.M. CHECKED JI	PROJECT LOCK & DAM #1 FILE No. 800 A DATE 4/18/75 PAGE 9 OF 9 PAGES

SUMMARY

MATERIAL	REHABILITATION OF BOTH LOCKS	REHABILITATION OF LAND LOCK ONLY
STRUCTURAL STEEL, TONS	300	180
LUMBER, BF/1000	143	85
TAR PAPER SQ. FT.	95,000	56,000
CANVAS SQ. FT.	27,000	20,000

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT UPPER GUIDE WALL REMEDIAL PRESSURE GROUTING COMPUTED VT CHECKED JJ	PROJECT LOCK AND DAM NO. 1 FILE No. 800A DATE APR 3 1975 PAGE 1 OF 1 PAGES

ASSUME THAT CRIBS IN MONOLITHS 8 - 13 NEED REMEDIAL GROUTING

LENGTH OF CRIBS $\Sigma L = 190$ FT
WIDTH OF CRIBS $= 18$ FT
HEIGHT OF ROCK FILL $= 11$ FT

ASSUME THAT HOLES WILL BE DRILLED AT 6 FT SPACING IN 3 ROWS

$$n = \frac{190}{6} \times 3 = 95 \text{ holes}$$

DEPTH OF DRILL HOLE = 732.7 − 706.7 = 26 FT

TOTAL LENGTH OF DRILLING

$$\Sigma L = 95 \times 26 = 2470 \text{ LIN FT}$$

DEPTH OF GROUTING − 11 FT EACH HOLE

ASSUME THAT GROUT TAKE IS 2 CU-FT/LIN FT

TOTAL VOLUME OF GROUT

$$11 \times 2 \times 95 / 27 = 77 \cong 80 \text{ CY}$$

COST

		$
SET-UPS	96 × $50	= 4,800
DRILLING	2470 × $10	= 24,700
GROUTING	80 × $160	= 12,800
	TOTAL	$42,300

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT REMOVAL OF BACKFILL BEHIND LAND WALL	PROJECT LOCK AND DAM No. 1
	COMPUTED VT CHECKED JI	FILE No. 800A
		DATE APR. 7 1975 PAGE ___ OF ___ PAGES

LENGTH FT	WIDTH FT	AREA FT^2
90	30	2,700
325	50	16,250
100	40	4,000
		22,950

DEPTH = 10 FT

VOLUME $22,950 \times \frac{10}{27} = 8,500$

SAY 9,000 CY

UNIT COST \$ 3.00

COST 9000 × 3 = \$27,000

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILIZING OF LAND WALL USING INCLINED ROCK ANCHORS	PROJECT LOCK AND DAM No. 1
	COMPUTED VT CHECKED JI	FILE No. 900 A
		DATE Apr. 7 1975 PAGE 1 OF PAGES

ALT. 1 1 3/8" SINGLE ANCHORS

Use 1 3/8" single anchors - 3 per monolith
Total number of anchors = 48
Length of anchor = 90 ft
Diameter of bore hole = 3 in

SET-UP
48 holes @ $400.00 = $19,200

DRILLING
Total length = 48 × 90 = 4,320 lin ft
Unit cost of 3" bore = $10.00 per lin ft
Cost of drilling 4320 × 10.00 = $43,200

PLACE, GROUT AND TENSION ANCHOR BARS

Anchor Bars
1 3/8" bars : w = 5.05 lb/ft
Total length = 48 × 90 = 4320 lin ft
Total weight = 4320 × 5.05 = 21,800 lbs

Grout
D = 3" = 0.25 ft
Volume of one hole V = $\frac{\pi}{4}$ × 0.25² × 90 = 4.41 cu ft
Total volume ΣV = 48 × 4.41 = 211 cu ft

Cost 4320 × $11.00 47,520

TOTAL 109,920

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILIZING OF LAND WALL USING INCLINED ROCK ANCHORS	PROJECT LOCK AND DAM No. 1
	COMPUTED VT CHECKED JI	FILE No. 800 A
		DATE Apr. 7 1972 PAGE 2 OF ___ PAGES

ALT. 2 1 1/4" DOUBLE ANCHORS

Use 1 1/4" double anchors - 2 per monolith
Total number of anchors = 32
Length of anchor = 95 feet
Diameter of bore hole = 4 in

SET-UP
32 holes @ \$ 400.00 = \$ 12,800

DRILLING
Total length = 32 × 95 = 3,040 lin ft
Unit cost of 4" bore = \$ 12.00 per lin ft
Cost of drilling 3040 × 12.00 = \$ 36,480

PLACE, GROUT AND TENSION ANCHOR BARS

Anchor Bars
1 1/4" bars ; w = 4.172 lbs/ft
Total length = 32 × 2 × 95 = 6080 lin ft
Total weight = 6080 × 4.172 = 25,400 lbs

Grout
D = 4" = 0.33 ft, L = 95 ft.
Volume of one hole $V = \frac{\pi}{4} \cdot 0.33^2 \cdot 95 = 8.3$ cu ft
Total volume $\Sigma V_{net} = 32 \times 8.3 = 265$ cu ft

Cost 3040 × \$ 15.00 \$ 45,600

\$ 94,880

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT STABILIZING OF LAND WALL USING INCLINED ROCK ANCHORS	PROJECT LOCK AND DAM No. 1
	COMPUTED VT CHECKED JL	FILE No. 800 A
		DATE Apr. 7, 1975 PAGE 3 OF ___ PAGES

ALT. 3 1¼" TRIPLE ANCHORS

Use 1¼" triple anchors - 2 per monolith
Total number of anchors = 32
Length of anchor = 100 feet
Diameter of bore hole = 5 in

SET-UP

32 holes @ \$ 400.00 = \$ 12,800

DRILLING

Total length = 32 × 100 = 3,200 lin ft
Unit cost of 5" bore = \$16.00 per lin ft
Cost of drilling 3200 × 16.00 = \$ 51,200

PLACE, GROUT AND TENSION ANCHOR BARS

Anchor Bars

1¼" bars, ω = 4,172 lbs/ft
Total length = 32 × 3 × 100 = 9600 lin ft
Total weight = 9600 × 4,172 = 40,050 lbs

Grout

D = 5" = 0.417 ft ; L = 100 ft
Volume of one hole $V = \frac{\pi}{4} \cdot 0.417^2 \cdot 100 = 13.66$ cu-ft
Total volume $\Sigma V_{net} = 32 \times 13.66 = 437$ cu-ft

Cost 3200 × 20.00 \$ 64,000

\$ 128,000

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT INTERMEDIATE WALL SHEAR KEYS, LOWER GATE MONO'S. COMPUTED JJ CHECKED VT	PROJECT LOCK AND DAM No1 FILE No. 800A DATE 4/75 PAGE ___ OF ___ PAGES

VERTICAL KEYS (2.0'Φ)

SET-UP $4 \times \$250.- \quad = 1,000$

DRILLING $L = 4 \times 40.0' = 160.0'$

$160.0' \times \$140.- \quad = 22,400$

CONCRETE $V = \frac{3.14 \times 2.0^2}{4} \times 160.0' \times \frac{1}{27} = 19 \text{ c.y.}$

$19.0 \text{ c.y.} \times \$120.- \quad = 2,280$

25,680

HORIZONTAL KEYS (2.0'Φ) $n = 8$

SET-UP AND DRILLING

$8 \times \$1,200.- \quad = 9,600$

CONCRETE $V = \frac{3.14 \times 2.0^2}{4} \times 6.0 \times 8 \times \frac{1}{27} = 6 \text{ c.y.}$

$6 \text{ c.y.} \times \$120.- \quad = 720$

10,320

TOTAL $25,680 + 10,320 = \$36,000$

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT BACKFILL TO STABILIZE DOWNSTREAM MONOLITHS OF RIVER WALL	PROJECT LOCK AND DAM No. 1
	COMPUTED VT CHECKED JI	FILE No. 800 A
		DATE APR. 9, 1975 PAGE 1 OF ___ PAGES

FOR COMPUTATION PURPOSES ASSUME 3 DIFFERENT GROUND ELEVATIONS.

ELEVATION	DISTANCE FT
700	80
690	40
680	30

~~EXCAVATION~~

~~ASSUME A DEPTH OF 3 FEET~~
~~AREA 80 × 160~~

~~$V = 80 \times 160 \times 3 \times \frac{1}{27} = 1420$ CY SAY 1500 CY~~

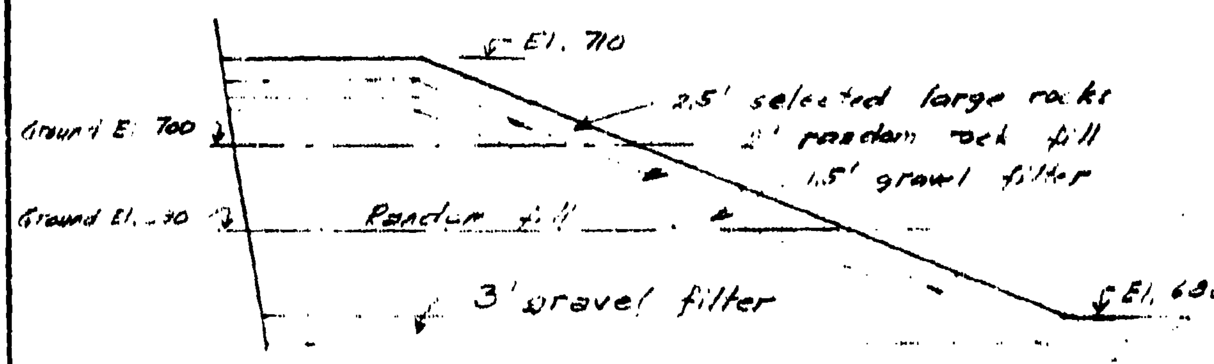
~~IMPERVIOUS BLANKET~~

~~MIN [illegible] = 3 FEET~~

~~V [illegible] (= EXCAVATION)~~

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT BACKFILL TO STABILIZE DOWNSTREAM MONOLITHS OF RIVER WALL	PROJECT LOCK AND DAM No. 1
	COMPUTED VT CHECKED JI	FILE No. 800 A
		DATE APR. 8, 1975 PAGE 2 OF ___ PAGES

CROSS-SECTION : GROUND ELEV. 680



Excavation	105 × 3 =	315 ft²
Impervious blanket	85 × 3 =	255 ft²
Random fill	50 × 24 =	1200 ft²
Gravel filter	108 × 15 =	162 ft²
Random rock fill	110 × 2 =	220 ft²
Selected large rocks	115 × 2.5 =	28[illegible] ft²

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT BACKFILL TO STABILIZE DOWNSTREAM MONOLITHS OF RIVER WALL	PROJECT LOCK AND DAM NO. 1
	COMPUTED VT CHECKED JI	FILE NO. 800 A
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GROUND ELEV. 690

Excavation	80 × 3 =	240 ft^2
Impervious blanket	60 × 3 =	180 ft^2
Random fill	38 × 14 =	532 ft^2
Gravel filter	78 × 1.5 =	117 ft^2
Random rock fill	83 × 2 =	166 ft^2
Selected large rocks	90 × 2.5 =	225 ft^2

GROUND ELEV. 700

Excavation	60 × 3 =	180
Impervious blanket	40 × 3 =	120
Random fill	26 × 4 =	104
Gravel filter	52 × 1.5 =	78
Random rock fill	57 × 2 =	114
Selected large rocks	62 × 2.5 =	155

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT BACKFILL TO STABILIZE DOWN-STREAM MONOLITHS OF RIVER WALL COMPUTED VT CHECKED JJ	PROJECT LOCK AND DAM NO. 1 FILE NO. 800 A DATE APR. 8, 1975 PAGE 4 OF ___ PAGES

EXCAVATION

$315 \times 30 = 9450$ ft³
$240 \times 40 = 9600$
$180 \times 80 = 14400$

33450 ft³ = 1238 cy

USE $1.15 \times 1238 = 1424$ cy → 1500 cy

GRAVEL FILTER

$255 \times 30 = 7650$ ft³
$180 \times 40 = 7200$
$120 \times 80 = 9600$

24,450 ft³

USE $24450 \times 1.15 \times \frac{1}{27} = 1041$ cy → 1100 cy

RANDOM FILL

$1200 \times 30 = 36,000$ ft³
$532 \times 40 = 21,280$
$104 \times 80 = 8,320$

65,600 ft³

USE $65600 \times 1.15 \times \frac{1}{27} = 2794$ cy → 3000 cy

FOR USE ON U.S. GOVERNMENT WORK ONLY

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT BACKFILL TO STABILIZE DOWNSTREAM MONOLITHS OF RIVER WALL	PROJECT LOCK AND DAM NO. 1
	COMPUTED VT CHECKED JI	FILE NO. 800 A
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GRAVEL FILTER

162 × 30 = 4860 ft²
117 × 40 = 4680
78 × 80 = 6240

15780 ft²

USE 15780 × 1.15 × 1/27 = 672 cy → 700 cy

RANDOM ROCK FILL

220 × 30 = 6600 ft²
166 × 40 = 6640
114 × 80 = 9120

22360 ft²

USE 22360 × 1.15 × 1/27 = 952 cy → 1000 cy

SELECTED LARGE ROCK

285 × 30 = 8550 ft²
225 × 40 = 9000
155 × 80 = 12400

29950

USE 29950 × 1.15 × 1/27 = 1275 cy → 1300 cy

HARZA ENGINEERING COMPANY CHICAGO	SUBJECT BACKFILL TO STABILIZE DOWNSTREAM MONOLITHS OF RIVER WALL	PROJECT LOCK AND DAM NO.
	COMPUTED VT CHECKED JL	FILE No. 800 A
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COST ESTIMATE

ITEM	QUANTITY	UNIT PRICE	COST
Excavation	1500 cy	3,00	$ 4,500
Gravel filter	1100	10,50	11,550
Random fill	3000	6,00	18,000
Gravel filter	700	10,50	7,350
Random rock fill	1000	16,00	16,000
Selected large rocks	1300	[illegible]	32,500
		TOTAL	$ 89,900